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THE SMOKING HABITS OF SCHOOL CHILDREN

BY

A STUDY GROUP OF THE PUBLIC HEALTH DEPARTMENT
London School of Hygiene and Tropical Medicine

In recent years there have been numerous reports about the relationship between smoking and carcinoma of the lung. The first published survey was carried out in Germany by Müller (1939). His findings have been confirmed by many other studies, including the extensive surveys of Wynder and Graham (1950) in the United States and Doll and Hill (1950) in England. The correlation between smoking, particularly cigarettes, and lung cancer is now widely accepted.

The continued increase in the incidence of bronchial carcinoma over the past few decades indicates that this condition is of major importance in public health to-day and may be of even greater importance in the future. Various attempts to warn, alarm, or merely to inform the public have had little or no obvious effect in changing the overall smoking habits of the population. To the group conducting the survey reported in this paper it seemed highly doubtful whether the approaches which have been tried are likely to prove effective. Since it is felt that smoking represents at least habituation, if not addiction, any effective programme for the control of lung cancer must be aimed at prevention of the habit of smoking until the specific carcinogens in tobacco can be identified and eliminated.

Several retrospective studies have been undertaken to ascertain the smoking habits of various groups, but those concerned with direct questioning of school children in Great Britain have been limited. The first (Jones, 1957) was based on a population of 307 boys in a secondary modern school. Of these, 38 per cent. had smoked before reaching the age of 11–12 years. Regular smoking rose sharply from 3 per cent. of the 11-year-olds to 44 per cent. of the 14-year-olds. Few smoked more than five cigarettes per week until the age of 13 to 14. Raven (1957) obtained his information from the head teachers of a variety of schools. Although many secondary modern school children had smoked their first cigarette before the age of 12, regular smoking was not observed until the ages of 13–14. Early smoking was found to have a negative correlation with intelligence and was commoner in urban than in rural districts. In grammar schools and public schools as compared with secondary modern schools, smoking was less common, started at a later age and the number of cigarettes smoked was less at comparable ages. Taylor (1957) studied the smoking habits of boys in one grammar school and two secondary modern schools. In the former, 45 per cent. of the 14–16 age group smoked, 23 per cent. being regular smokers. In the latter, 62 per cent. of the 14-year-old boys smoked, 19 per cent. regularly.

All of these studies have demonstrated that the secondary school age is a critical period in the formation of smoking habits. The present report presents the results of a survey which, it is hoped, will serve as a basis for planning a more intensive search into the factors involved in the acquisition of the smoking habit by school children.

Method

Although questionnaires present several disadvantages for obtaining accurate information, it was decided that this method was the most practicable for a large survey in a group of schools. Construction of an appropriately simple questionnaire was accomplished with the aid and advice of Dr. Richard Doll. As a preliminary study the questionnaire was presented to three classes of secondary modern school boys approximately 3 months before the full scale study. It was found that only minor modifications were needed. Comparison with the answers given by the same pupils 3 months later served as a

check both on memory and on the reliability of the method.

Questionnaires were completed in the classrooms. Instructions and questions were read to the pupils by their own teachers. To encourage truthful replies the confidential nature of the inquiry was stressed. In all but 25 out of 127 classes the completed forms were collected and placed in a sealed envelope by a member of the study group who was present to clarify any misunderstandings.

For the purpose of classifying smoking experience two arbitrary reference points were established:

(1) as little as one puff of a cigarette should be counted as "having smoked";
(2) the smoking of five or more cigarettes a week was defined as "regular" smoking.

POPULATION STUDIED.—Through the co-operation of the Medical Officer of Health and the head teachers, it was possible to make a complete survey in two grammar schools and four secondary modern schools of an industrial County Borough near London. Tables I and II show the distribution of the children by age, sex, and type of school, and the percentages of children who completed the questionnaire satisfactorily.

No attempt was made to obtain information from those who were absent on the day of the survey. Questionnaires were rejected when the answers given were either insufficiently complete or confused, or if the child's age was not recorded. In all, 3,479 questionnaires representing 90 per cent. of the total school population and 98 per cent. of the children available for investigation were included in the analysis.

TABLE II

QUESTIONNAIRES USED FOR ANALYSIS, BY SEX, AGE, AND TYPE OF SCHOOL

Sex		Boys		Girls	
School		Grammar	Secondary Modern	Grammar	Secondary Modern
Age (yrs)	11—	67	187	66	175
	12—	136	246	96	242
	13—	159	277	111	285
	14—	151	243	115	276
	15—	110	65	106	80
	16—	67	19	54	22
	17+	70	—	54	—
	Total	760	1,037	602	1,080
Total by Sex		1,797		1,682	
Grand Total		3,479			

The population is fairly evenly distributed throughout the age groups. The paucity of 11-year-old grammar school children can probably be explained by differences in selection for entry to these schools. The smaller 15- and 16-year-old groups in secondary modern schools are due to the earlier leaving age in this type of school.

RESULTS

As might have been expected, the overall results show first that the degree of smoking experience is related to the age of the group and secondly that the figures for boys are consistently higher than those for girls of the same age (Table III, opposite). In addition, it is apparent that the percentages are higher among secondary modern school children than among grammar school children of the same age, but these differences are less striking among the girls than among the boys.

TABLE I

NUMBER OF SCHOOL CHILDREN INCLUDED IN SURVEY

Sex	Type of School	Number of Children on Register (*a*)	Number of Children Absent during Survey	Number of Questionnaires Rejected	Number of Questionnaires Used for Analysis (*b*)	Percentage of Total $\frac{b}{a} \times 100$
Boys	Grammar	820	58	2	760	93
	1. Secondary Modern	730	89	28	613	84
	2. Secondary Modern	467	40	3	424	91
	Total	2,017	187	33	1,797	89
Girls	Grammar	648	30	16	602	93
	1. Secondary Modern	529	43	4	482	91
	2. Secondary Modern	659	53	8	598	91
	Total	1,836	126	28	1,682	92
Total		3,853	313	61	3,479	90

TABLE III

PERCENTAGE OF CHILDREN WHO HAD SMOKED, BY SEX, AGE, AND TYPE OF SCHOOL

Sex		Boys		Girls	
School		Grammar	Secondary Modern	Grammar	Secondary Modern
Age (yrs)	11—	40·3	71·1	21·2	38·0
	12—	47·8	81·7	40·6	43·4
	13—	58·5	84·9	45·0	56·1
	14—	66·2	89·3	53·9	59·8
	15—	74·5	86·2	63·2	61·3
	16—	80·6	89·5	61·1	36·4
	17—	72·9	—	75·9	—

According to our definition, 8 per cent. of all the children in the survey qualified as "regular" smokers. Analysis, on the basis of age, sex, and type of school, revealed trends similar to those for general smoking experience (Table IV). The levelling off in the boys and the irregularity in the figures for girls over 15 years of age may be due to sampling errors arising from the smallness of the groups or to a process of selection among those who had passed the school-leaving age.

TABLE IV

PERCENTAGE OF REGULAR SMOKERS*, BY SEX, AGE, AND TYPE OF SCHOOL

Sex		Boys		Girls	
School		Grammar	Secondary Modern	Grammar	Secondary Modern
Age (yrs)	11—	0	3·2	0	0
	12—	0	9·8	0	0·4
	13—	1·9	21·3	1·8	2·8
	14—	15·9	29·6	5·2	3·6
	15—	25·5	35·4	4·7	5·0
	16—	23·9	31·6	3·7	0
	17—	27·1	—	3·7	—

i.e. five or more cigarettes/week*

Table V shows the smoking habits of the 260 boys aged 11–16 years who were regular smokers. One third of those aged 14–16 were smoking more than twenty cigarettes a week.

TABLE V

HABITS OF REGULAR SMOKERS AGED 11–16

Age Group (yrs)	Percent Smoking (Cigarettes per Week)				No. in Group
	5–9	10–19	20–39	40 or more	
11–13	46	34	13	7	92
14–16	36	31	21	12	168

The distribution of the intervals between the first smoking experience and the onset of regular smoking among the group of regular smokers is shown in Table VI. The majority of these acquired the habit within one year of their first cigarette and nearly 95 per cent. within 3 years. The numbers in various age groups were not sufficiently large to evaluate the influences of age with respect to the rapidity of development of the habit.

TABLE VI

INTERVAL BETWEEN FIRST SMOKING EXPERIENCE AND ONSET OF REGULAR SMOKING AMONG BOYS AGED 11–16

Interval (yrs)	Number of Regular Smokers	Percentage of Total
0—	159	61
1—	59	23
2—	28	11
3—	3	1
4—	6	2
5—	5	2
Total	260	100

Table VII shows the percentages of secondary modern school boys who had smoked, according to age group and intelligence. The difference is not statistically significant but over the age of 12 the proportion of boys who had smoked was consistently higher in the lower stream.

TABLE VII

RELATIONSHIP BETWEEN INTELLIGENCE AND SMOKING AMONG SECONDARY MODERN SCHOOLBOYS

Stream	Percentage who had Smoked in Each Age Group					
	11—	12—	13—	14—	15—	All Ages
Upper	72·4	77·2	82·4	87·4	85·7	81·2
Lower	69·9	89·2	86·3	92·4	93·3	84·7

(For all ages $P > 0{\cdot}1$)

DISCUSSION

In a study of this type, one may always question the validity of the answers given. Every effort was made to stress the confidential nature of the inquiry in order to obtain answers which were as truthful as memory would permit. On the basis of comparison of answers given 3 months apart by a group of 81 secondary modern school boys aged 11–15, it was felt that the answers given were relatively reliable. 68 who had stated that they had smoked at the time of the first questionnaire gave the same answer the second time. One who had answered "No" on the first occasion converted to "Yes". The answers concerning the age at which they had first smoked showed some variation, though this was not great: 47 per cent. gave the same age on both occasions, 39 per cent. showed a variation of plus or minus one year, and 12·5 per cent. showed a variation of plus or minus 2 years.

It is difficult to compare the specific results of this survey with those obtained by other workers in

other areas of Great Britain because the methods of questioning and classification differ. In general, however, this study confirms the findings of others in indicating that smoking is a relatively common practice among children of secondary school age, that there are definite age and sex differences, and that certain environmental factors may play a significant role in influencing the patterns of smoking experience.

For both boys and girls there is a consistent increase with age in the percentage of the group who have smoked at some time in their lives. Figures for boys are invariably higher than those for girls of the same age and those for secondary modern school children are consistently higher than those for the same age groups in grammar schools. This latter difference, however, is far less striking among girls than among boys.

The differences noted between the smoking patterns of secondary modern school as compared with grammar school children suggests a possible inverse relationship with intelligence. Though intelligence may be an important factor in this instance, such a relationship is less evident when one compares the upper stream and lower stream boys within the secondary modern schools. It is possible, therefore, that the school environment may play as great a role as intelligence in the development of smoking patterns. However, detailed conclusions cannot be drawn from these results.

Perhaps the most impressive findings were the high percentage of 11-year-old children who had already smoked, the percentage over the age of 13 who were regular smokers, and the relative rapidity with which the regular smokers developed the habit.

The overall results and impressions gained from this survey suggest that the secondary school age group should offer fertile ground for a school health education programme concerned with smoking. The specific roles of the various environmental and psychological factors involved require much more detailed studies. It is hoped that these further explorations may be carried out in the near future since the structure of an effective health education programme would depend to a large extent on the findings of such a study.

Summary

Nearly 3,500 boys and girls aged 10 to 18 years, representing 90 per cent. of the pupils at four secondary modern and two grammar schools in an industrial County Borough, were questioned about their cigarette smoking experiences. The smoking habits of these children have been related to age, sex, type of school, and intelligence.

The results indicate that smoking is a problem of significant importance among school children in an area such as the one surveyed. Smoking is commoner among boys than among girls and also commoner in secondary modern than in grammar school children. It is possible that the cultural pattern of the school may be as important as intelligence in influencing smoking behaviour. Among those boys who had become regular smokers, over 80 per cent. did so within 2 years of smoking their first cigarette.

It is suggested that there is an urgent need for health education in schools to abate smoking. This should be based on the results of further surveys aimed at determining those factors which may be important in influencing children to smoke.

We wish to thank Dr. J. S. Coleman, Medical Officer of Health, who enabled us to carry out this study; the headteachers and staff of the schools for their co-operation; Dr. Richard Doll for his advice in planning the questionnaire; and Miss V. Follenfant and Miss J. Cooper for their assistance at various stages of this investigation.

The study group consisted of the following:

S. P. W. Chave and R. S. F. Schilling, Staff Members of the London School of Hygiene and Tropical Medicine.

D.P.H. students of this School:

E. J. Coulter
W. R. Davies
R. W. McCollum
W. H. McDonald (*Chairman*)
W. R. McKibben
R. Neumann
J. H. Sewart
L. S. Sodhy
G. S. Udall (*Secretary*)

Senior students from the Royal College of Nursing:

R. A. Davis
A. Pope
E. D. Shaw
J. L. Wanigasuriya

The first draft of this report was prepared by R. W. McCollum. Inquiries about this study should be addressed to S. P. W. Chave.

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SMOKING HABITS AMONG SCHOOL CHILDREN IN NORWAY

BY

EGIL NILSEN

The Norwegian Cancer Society, Oslo

Mortality from lung cancer among urban males has in the last 20 years risen 10-fold in Norway. This fact, seen in relation to the connexion between smoking and lung cancer, makes excessive smoking a serious problem. Understanding the difficulty of making an adult habitual smoker stop smoking, the Norwegian Cancer Society has found it necessary to begin preventive work among the young.

A Committee on the Smoking Habits of Young People was therefore appointed by the Society in 1956. The committee decided to make a survey of smoking habits among children and teen-agers before embarking on an anti-smoking campaign. The methods used and some of the results of this survey are described in the present paper. A more detailed analysis of the material, especially with respect to motivational factors, is to be published elsewhere (Nilsen).

Many surveys have been made in the last few years of smoking habits among groups of adults, but only a few of them specify smoking habits among young people.

Kreyberg (1954) used 15–24 years as the lowest age group in his sample from Norway. This is a very wide range, and as the sample consists of seven special groups from the population, it does not provide a representative picture of the smoking habits of Norwegian youth.

In other surveys outside Norway the age group 15–19 years has been the lowest represented in the sample, or the respondents have been asked when they began to smoke. Hamtoft and Lindhart (1955, 1956) made a nationwide survey of smoking habits among adults in Denmark, Ossadnik (1954, 1955) in Austria, Haenszel, Shimkin and Miller (1956) in the United States, and Tuyns (1956) in an urban population in Belgium; all these authors used the range of 15 to 19 years as the lowest age group either for current smoking or for the age when the respondents began smoking.

Very few surveys have been concerned with children and young people only, Dybdahl (1957) studied smoking habits among school children in the town of Stavanger, Norway, and the rural districts surrounding it. In Sweden a nationwide survey was made of smoking habits among school children from 10 to 18 years of age (Skolungdomens Roekvanor, 1956). Smoking habits were included in two Danish surveys of youth (Ungdomskommissionen, 1951; Alkjaer, 1956). Jones (1957) made a study of smoking habits among boys in a British secondary school.

Of these surveys the Swedish report has the advantage both of being nationwide and of providing enough data to allow smoking habits at each year of age to be estimated.

The present survey aimed at acquiring information about smoking habits at each year of age from 13 to 19 in the whole of Norway, and is therefore in this respect more like the Swedish survey than any of the others mentioned above.

Material and Methods

The data were gathered through questionnaires. In order to check the answers and to get more information about smoking habits, a sample of the respondents was also interviewed.

It is difficult to make a survey of smoking habits among children. It is undesirable to mail the questionnaires because the respondents should preferably not know the questions beforehand. As many of the

respondents are probably "not allowed" to smoke by their parents, an interview at home is not desirable because the parents must not know the answers. The respondents should be able to answer the questions so that no one except perhaps the interviewer knows from whom the individual answers come.

The simplest way to do this is to let the respondents answer the questionnaire anonymously in school, without knowing the questions beforehand, or to interview them one at a time in a separate room in school. By this method only the smoking habits of school children will be surveyed. In spite of this handicap, however, this method was used in the present study. To make a nationwide and reliable survey of smoking habits among all young people, including those who had left school, would have been very expensive and it would have been more difficult to check the reliability of the answers.

Another and more important reason for surveying smoking habits among school children only, is that the practical aim of the survey was to make an anti-smoking campaign more effective. As a campaign of this kind has to be carried out primarily through the schools, it is the smoking habits of school children which are of especial interest.

The schools from which the sample of respondents was taken, were of various types, including public primary schools, continuation schools, secondary general schools, folk high schools, and vocational workshop and apprenticeship schools.

The numbers in each age group represented in these schools is obtained by comparing the age distribution in the total population with that of the pupils. The age distribution of the sample of respondents from each type of school is used to estimate the age distribution of all pupils attending that type of school.

When the whole population is compared with the school population, we find as would be expected, that children of 13 to 14 years of age are almost fully represented in the schools, while only 10 per cent. of the 19-year-old group is still attending schools of the types sampled.

Although the population from which the sample is taken is therefore not representative of the whole population of young people, we have tried to make the sample representative of this population of young people at school. We have found this especially necessary for the public primary schools, because most of the age groups sampled are to be found in this type of school.

The schools were classified in the types listed above and sub-divided further into:

(*i*) Schools in the capital city, Oslo,

(*ii*) Other urban schools,

(*iii*) Rural schools.

From the rural public primary schools and continuation schools a cluster sample has been taken, using the rural municipalities as cluster units. For this purpose a systematic sample was drawn of about 5 per cent. of all the rural municipalities. All the pupils in the continuation schools and all the pupils in the Seventh Grade in the public primary schools* in these chosen municipalities then received a questionnaire.

From the cities, excluding Oslo, a two-stage sample was taken, using the urban municipalities as primary sampling units. The sample of municipalities was taken in such a way that the probability that a city would be included was proportional to the number of public primary schools in the city, and from each town appearing in the sample one school was drawn†. This was done by drawing a systematic sample of about 10 per cent. of all the urban public primary schools. Every pupil in the Seventh Grade in the sampled public primary schools received a questionnaire, and in the cities which also had continuation schools, a 10 per cent. sample of classes was taken from this type of school.

While taking a 5 per cent. sample of rural schools and a 10 per cent. sample of urban schools outside Oslo, it was necessary to take a 20 per cent. sample from Oslo to obtain enough respondents to break down the material into the required sex-age groups.

The school inspector of Oslo classified the public primary schools into eastern, western, and central districts, and from each group a simple random sample of schools was taken. A sample of classes from the two continuation schools was taken directly from the schools.

For the secondary schools and the two types of vocational school, a systematic sample of classes was taken from the same municipality as those from which the public primary schools were sampled. A sample of folk high schools was taken directly from these schools for the whole country without further subdivision.

* The Seventh Grade includes about half the 13-year-olds; the rest would be in the Sixth Grade.

† This procedure makes the sample a self-weighting one where we can use a very simple and unbiased estimate.

Table I shows the number of respondents in relation to the total number of pupils in the respective classes.

The secondary general schools have been grouped into schools of Oslo and all other schools in the official statistics on education, as Table I shows. The folk high schools are all rural and most of the vocational schools are urban.

The sex and age distribution of the respondents in the respective school types is shown in Table II.

The questionnaires were distributed to the schools with an introductory letter to the teacher and a printed guide which the teacher was asked to read aloud to the class. Every pupil was given an envelope in which to put his questionnaire when it was answered. The envelopes were sealed and then collected in a larger envelope which was sent at once by post to the Norwegian Cancer Society. This was done so that the pupils could be sure that the answers would be anonymous and that they could therefore answer honestly with impunity. No name or other identification was written on the questionnaire. All the children who were present in the classes represented in the sample on the day of the test answered the questionnaire.

TABLE I

NUMBER OF RESPONDENTS AND TOTAL POPULATION IN TYPES OF SCHOOL SAMPLED

Type of School		Public Primary (7th Grade)	Continuation	Secondary General	Folk High	Vocational
Sample	(i) Oslo	1,118	391	827		331
	(ii) Other Towns	782	311	2,858		341
	(iii) Rural Districts	1,285	660		387	
	Total	3,185	1,362	3,685	387	672
Population	(i) Oslo	4,421	2,054	8,995		3,090
	(ii) Other Towns	8,180	3,759	40,105		9,005
	(iii) Rural Districts	36,850	20,659		4,015	
	Total	49,451	26,472	49,100	4,015	12,095
Sampling Fraction	(i) Oslo	0·25	0·19	0·09		0·11
	(ii) Other Towns	0·10	0·08	0·07		0·04
	(iii) Rural Districts	0·04	0·03		0·10	
	Total	0·06	0·05	0·08	0·10	0·06

TABLE II

NUMBER OF RESPONDENTS BY TYPE OF SCHOOL, AGE, AND SEX

Sex	Age (yrs)	Type of School: Public Primary (7th Grade)	Continuation	Secondary General	Folk High	Vocational	Total Respondents
Male	Under 13	16	—	—	—	—	16
	13	806	1	5	—	—	812
	14	760	258	223	—	4	1,245
	15	56	381	413	2	46	898
	16	—	59	399	27	115	600
	17	—	2	417	53	126	598
	18	—	—	283	36	112	431
	19	—	—	122	6	69	197
	20 and Over	—	—	68	11	91	170
	Total	1,638	701	1,930	135	563	4,967
Female	Under 13	13	—	—	—	—	13
	13	826	1	9	—	—	836
	14	671	173	235	—	—	1,079
	15	36	378	407	5	11	837
	16	1	104	391	57	17	570
	17	—	5	354	104	16	479
	18	—	—	238	52	15	305
	19	—	—	83	16	9	108
	20 and Over	—	—	38	18	41	97
	Total	1,547	661	1,755	252	109	4,324

As mentioned before, a sample of respondents was also interviewed. This sample was taken from the respondents in Oslo from all types of school. The number of such interviews is shown in Table III.

Results

After questions about sex and age, the questionnaire asked the following questions, with instructions to mark only one of the answers and to answer honestly:

Do You Smoke?

(..) *Daily*
(..) *Sometimes*
(..) *Very seldom*
(..) *Never*

The answers are shown in Table IV, where respondents who have answered "Sometimes" or "Very seldom" have been called occasional smokers and all types of school in Oslo, other towns, and rural districts were grouped together. The percentages in Table IV were derived from the weighted sums of the number of smokers and non-smokers in each district, using the inverse of the sampling fractions in Table I as the weights in each sex-age group, and dividing by the estimated total population of that group. The formula is simply:

$$P = 100 \sum \frac{r_i}{f_i} \Big/ \sum \frac{n_i}{f_i}$$

for each sex-age group, where P is the percentage in the sex-age group in Table IV, r_i is the number of daily smokers, occasional smokers, or non-smokers among the respondents in the district (i), n_i is the total number of respondents and f_i is the sampling fraction, both in the same district and in the same sex-age group. The percentages in Table IV are therefore ratio-estimates of the percentages in the respective sex-age groups in the whole school population comprising the types of school from which our sample has been drawn.

The estimate of the variances and standard errors are very complicated in our sampling design. The sample plan was devised to obtain unbiased estimates with the least possible variances, when practical and economical considerations were also taken into account.

The division into districts should have reduced the variances and the cluster sampling should have increased them in relation to the variances in simple random sampling. There is reason to believe that the intraclass correlation in the clusters will not be very much above zero. The total effect of using district cluster sampling with simple random sampling of clusters from every district should therefore probably be a reduction of the variances in relation to simple random sampling.

In the districts where the clusters have been sampled with probability proportionate to the size of the clusters and with subsampling, the variance will be still more reduced.

Table III
NUMBER OF INTERVIEWS IN OSLO, BY TYPE OF SCHOOL, AND SEX

Type of School		Public Primary (7th Grade)	Continuation	Secondary General	Vocational	Total Interviewed
Sex	Male	27	36	39	42	144
	Female	22	50	40	5	117
	Total	49	86	79	47	261

Table IV
SMOKING HABITS BY SEX AND AGE (PERCENTAGES)

Sex	Smoking Habits	Age (yrs)						
		13	14	15	16	17	18	19
Male	Daily Smokers	3	7	13	24	35	38	35
	Occasional Smokers	54	51	47	38	27	28	28
	Non-Smokers	43	42	40	38	38	34	37
	Total	100	100	100	100	100	100	100
Female	Daily Smokers	—	—	3	4	11	17	13
	Occasional Smokers	25	36	36	38	34	44	40
	Non-Smokers	75	64	61	58	55	39	47
	Total	100	100	100	100	100	100	100

In most of the districts the clusters have been sampled by systematic sampling and it is difficult to make an estimate of the variance from such a sample. We know that if the serial correlation is greater between adjacent sampling units than between units farther apart, the variance will be reduced by systematic sampling in relation to simple random sampling. Since, however, we have no evidence from our material, it will be safer to assume the same variances as if we were dealing with simple random sampling.

From all these facts we may conclude that, if for every sex-age group we use a simple random sample estimate of the variance, we should in most instances be overestimating the real variance.

Comparing Tables II and IV we find that the smallest number of respondents in the sex-age groups we have used is 108. As the standard error $\sigma = \sqrt{PQ/n}$ is maximum when $P = Q = 50$, we may therefore conclude that for all the percentages in Table IV the standard error will be less than $\sqrt{50 \cdot 50/108} \simeq 5$. For most of the sex-age groups it will be about 2·5. This means that, for most of the percentages in Table IV, differences between them will be statistically significant at the 0·01 level if they are not smaller than 10.

For the 13- and 14-year age groups the percentages in Table IV are relatively good estimates of the percentages in the whole population in these age groups. But the higher the age group the more biased are the percentages in the Table as estimates of the percentages in the whole age group.

What Table IV tells us, then, is that, among the adolescents still at school, the percentage of daily smokers increases rapidly with increasing age up to the age of 18 where it appears to reach a temporary maximum. The percentage of occasional smokers decreases with increasing age.

To get an impression of smoking habits among *all* young people, whether at school or not, we may compare the types of school. The number of pupils contributed to our sample by the folk high schools is too small to break down into age groups; for the other types of school Table V shows the percentage of daily smokers among boys by age and type of school.

Relatively few of the pupils in the continuation schools go on to secondary general schools, but they may go to vocational schools or to folk high schools if they continue to go to school at all. A comparison between Tables IV and V, therefore, shows that the increasing proportion of daily smokers with increasing age is probably greater in the whole population of young people than is shown in Table IV for the school population. Thus, Table V shows that the proportion smoking at ages 14 and 15 is greater in the continuation schools, *i.e.* among pupils relatively few of which will go to another school after leaving the continuation school. With increasing age, therefore, when more and more of the children leave school, there will be relatively fewer smokers left in school, and therefore also fewer in our sample of school children.

TABLE V

PERCENTAGE DAILY SMOKERS AMONG BOYS BY AGE AND TYPE OF SCHOOL

Type of School	Age (yrs)						
	13	14	15	16	18	17	19
Public Primary ..	3	5	—	—	—	—	—
Continuation	—	9	14	20	—	—	—
Secondary General ..	—	6	9	24	30	33	25
Vocational	—	—	—	26	45	52	52

Table V also shows that there are more smokers in the vocational schools than in the secondary general schools. The pupils in the former group attend school in the evening or one day a week, having full-time jobs as apprentices during the rest of the week. The high incidence of smokers among pupils in this type of school makes it also probable that the percentage of smokers among the senior teen-agers in the population is higher than in our sample of school children. This will be true if the young workers not attending vocational schools smoke as much as those who do.

For the pupils in the public primary schools we may compare urban and rural schools. As Table VI shows, occasional smokers are more common in rural districts than in towns. Analysis of the age

TABLE VI

SMOKING HABITS AMONG PUPILS IN 7th GRADE OF PUBLIC PRIMARY SCHOOLS BY DISTRICT AND SEX (PERCENTAGES)

Sex	Smoking Habits	District		
		(i) Oslo	(ii) Other Towns	(iii) Rural Districts
Male	Daily Smokers ..	4	6	5
	Occasional Smokers	45	47	57
	Non-Smokers ..	51	47	38
	Total	100	100	100
Female	Daily Smokers ..	1	1	1
	Occasional Smokers	17	18	36
	Non-Smokers ..	82	81	63
	Total	100	100	100

distribution and comparison with the corresponding Swedish survey (Skolungdomens Roekvanor, 1956), the other Norwegian survey among school youth (Dybdahl, 1957), and a Norwegian Gallup poll, shows that this difference is likely to be real, but that it only concerns children under 15 years of age. On the other hand for all daily smokers, and for occasional smokers from 15 years and upwards, the difference is in the opposite direction, and more smokers are found in urban than in rural districts.

Our survey also shows that there are more smokers among the parents of children in towns than in rural districts: in Oslo, other towns, and rural districts, respectively, 85, 81, and 70 per cent. of the school children in the Seventh Grade of public primary schools answered that one or both of their parents smoked.

In Oslo, a comparison of the eastern and western public primary schools shows that 35 per cent. of the pupils in the eastern districts smoked occasionally against 23 per cent. of those in the western districts. Here too the difference is in the opposite direction for smoking among parents. In the eastern schools 82 per cent. of the children answered that their parents were smokers, while the corresponding percentage in the western schools was 91.

The group, described as "Daily smokers" is a very heterogenous one including both heavy smokers and those who smoke only one cigarette a day, as well as cigarette smokers, mixed smokers, and pipe smokers.

In the youngest age group pipe smoking is not very common, but among boys it increases from 2 per cent. at the age of 13 to 13 per cent. at the age of 18.

The daily consumption of cigarettes in each age group is shown in Table VII. The formula for the weighted total mean is the same as the formula on page 8, but r_i is replaced by $\Sigma_k x_{ik}$, where x_{ik} for each sex age group is the number of cigarettes consumed per day by Respondent k in District (i).

A comparison of Tables IV and VII shows that not only does the number of daily smokers increase with age, but that their consumption increases also. The mean number of cigarettes consumed daily *per respondent* shows therefore a greater increase with increasing age than the mean number of cigarettes *per daily smoker*. Among 19-year-old boys the consumption per respondent is nearly forty times as great as among 13-year-old boys.

TABLE VII

DAILY CONSUMPTION OF CIGARETTES AMONG DAILY SMOKERS, BY AGE AND SEX (PERCENTAGES)

Sex	Number of Cigarettes per Day	Age (yrs)						
		13	14	15	16	17	18	19
Male	1	4	2	—	1	—	—	—
	2	19	22	10	6	4	4	5
	3	56	15	16	7	3	6	1
	4	1	8	14	14	6	5	5
	Total 1–4	80	47	40	28	13	15	11
	5–9	8	45	41	48	45	37	28
	10–14	12	8	10	15	25	25	32
	15–19	—	—	7	7	13	18	21
	20 and More	—	—	2	2	4	5	8
	Total	100	100	100	100	100	100	100
	Mean Number of Cigarettes per Daily Smoker	4·2	5·6	7·1	8·1	10·1	10·6	12·0
Female	1	32	—	8	—	—	—	—
	2	—	—	21	4	21	11	7
	3	12	11	25	27	15	8	16
	4	12	—	12	26	12	16	7
	Total 1–4	56	11	66	57	48	35	30
	5–9	44	54	16	22	37	54	48
	10–14	—	35	12	10	9	11	7
	15–19	—	—	3	4	6	—	15
	20 and More	—	—	3	7	—	—	—
	Total	100	100	100	100	100	100	100
	Mean Number of Cigarettes per Daily Smoker	4·5	8·8	5·6	7·2	6·3	6·5	8·0

Since the survey is cross-sectional, we cannot determine how the consumption varies with increasing age in individuals. But the results make it very probable that the individual trend is from occasional smoking to daily smoking, and then to an ever-increasing daily consumption with increasing age until a maximum is reached.

DISCUSSION

In a survey using questionnaires we have no way of checking the honesty of answers, how well the respondents have understood the questions, and what the correspondents really mean by their answers. The interview material has been used to test the reliability of the written answers.

During an interview one can hope to get at the real meaning of an answer and one can be fairly sure that the answer is honest; the answers from the interviews are therefore more reliable than those to the questionnaires. If the questionnaire answers therefore show the same distribution as the interview answers from the same group of respondents, the reliability of the questionnaire answers is supported.

Table VIII shows a comparison between the interview answers and the questionnaire answers from the respondents in Oslo; there are only slight differences between the two groups, but we may perhaps conclude that boy smokers are more numerous than the questionnaire material shows.

TABLE VIII

COMPARISON BETWEEN INTERVIEW AND QUESTIONNAIRE ANSWERS IN OSLO, BY SEX AND SMOKING HABITS

Sex	Smoking Habits	Questionnaire	Interview
Male	Daily Smokers	25	31
	Occasional Smokers	34	38
	Non-Smokers	41	31
	Total	100	100
Female	Daily Smokers	7	3
	Occasional Smokers	29	30
	Non-Smokers	64	67
	Total	100	100

It is important to know not only the degree of honesty of the answers, but what the respondents mean by their answers. The definition of daily smokers should be quite clear, but the answers "Sometimes" and "Very seldom" which we have taken together as "Occasional smoking", is open to question. The definition of this group should be clear if the definition of the answer "Never" is clear. But that is not the case. Do the respondents who have answered "Never" mean that they never smoke now or that they have never smoked at any time?

The interviewees who answered "Never" were therefore asked if they had ever tasted a cigarette. To this question many of the respondents answered "Yes". Of the 68 boys interviewed who had answered "Never", 55 had in fact tasted a cigarette, and of the 118 girls, 61 had tasted a cigarette. This means that of all those interviewed, 93 per cent. of the boys had tasted a cigarette or smoke now, and 66 per cent. of the girls. The answer "Never" must therefore mean only that the respondents do not smoke now even if they have tasted a cigarette earlier.

What can the results tell about smoking habits among other young people, apart from school children? We have mentioned before that it is probable that the percentage of smokers increases more rapidly with increasing age in the total population than in the school population. From a Gallup Poll undertaken for the Norwegian Cancer Society we may get material which can tell something about this.

Adults were asked if they smoked and if so how old they had been when they began to smoke daily. The Figures (overleaf) show the cumulative percentage distribution of the answers by age group. The percentages from our survey among school children are shown in the same Figures by hatching.

The trend shown by this figure is quite clear, that those in the younger age groups started smoking at an earlier age than the older ones, at least among women. From the Gallup Poll we would therefore estimate the frequency of daily smokers among children now aged 14 to 19 years as higher than it had been for persons in the older age groups when *they* were aged 14 to 19 years. The Figures show this to be true only for the lowest age groups among *school* children. The excess of daily smokers among school children decreases with increasing age from 14 to 19 years until the frequency of smokers in this group is lower than in the Gallup material.

From this we can conclude that our hypothesis that the percentage of smokers increases more rapidly with increasing age in the total population of youth than among school youth is most probably true.

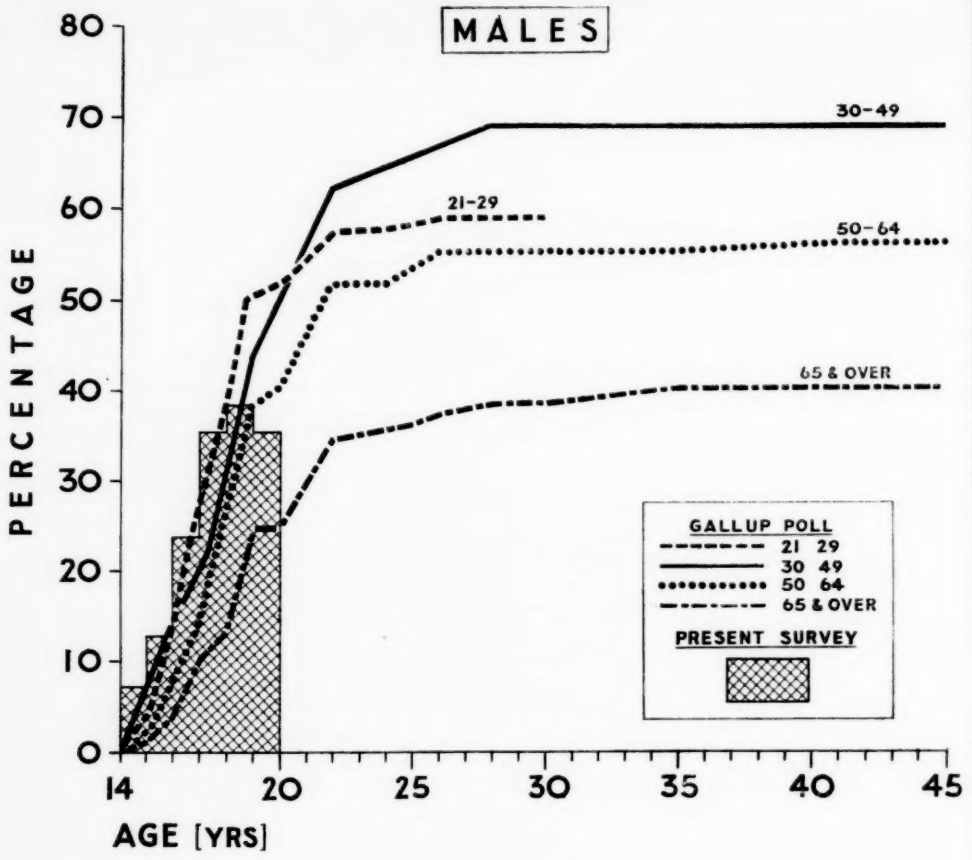
The Figures also show that most of the male smokers, and in the lower age groups the female smokers also, began to smoke between the ages of 13 and 18 years. This is true especially for the younger age groups. The temporary maximum we have found at about 18 years of age in our material is therefore a true maximum; relatively few habitual smokers begin their "smoking career" after that age.

SUMMARY

In a survey of the smoking habits of school children in Norway, 9,291 pupils from various types of school and from 13 to 20 years of age received a questionnaire with questions about their smoking habits.

The results show that occasional smoking is very common, especially among boys. Daily smoking is rarer. The percentage of daily smokers among boys increases from 3 per cent. at the age of 13 to a temporary maximum of 38 per cent. at the age of 18. Among the girls these percentages are 0 and 11.

Among 13 to 14-year-old pupils, occasional smokers are more common in rural districts than in towns, and in Oslo occasional smokers are more common in the eastern districts than in the western districts.



A further analysis of the material and a comparison with the results from an interview study of a sample of the respondents and from a Gallup Poll among adults, shows that these results are reliable, with the following reservations:

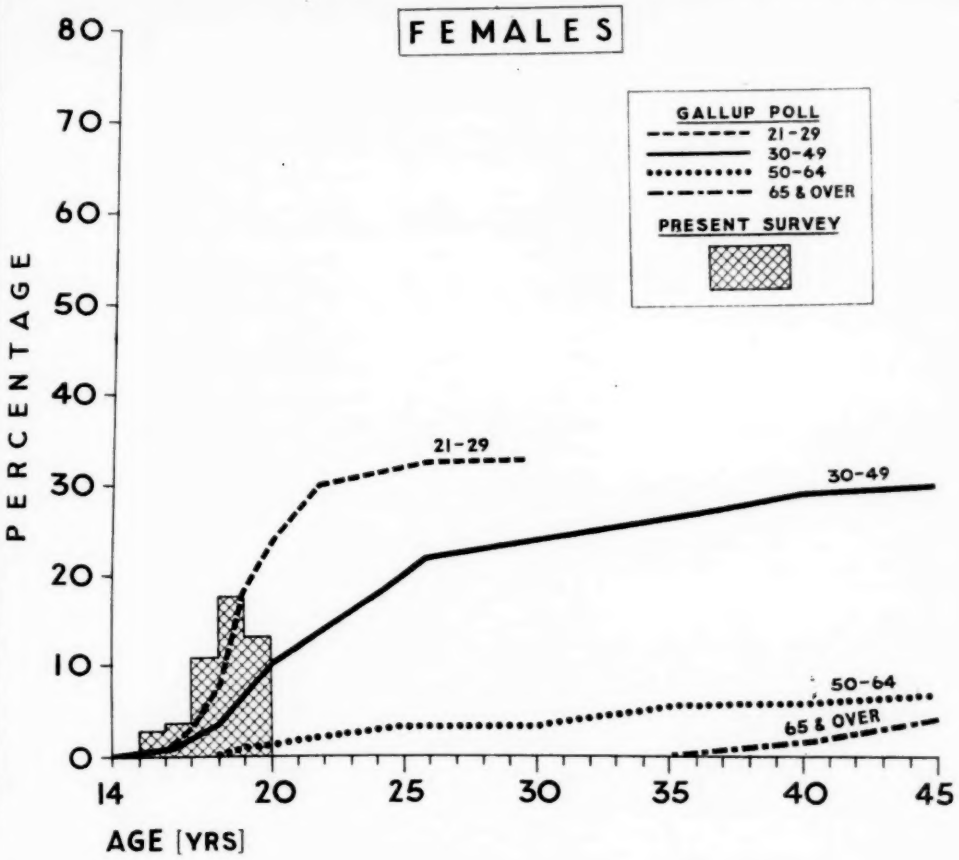
(*a*) The results show only the respondents' smoking habits at the time when the survey was undertaken. Most of the boys had tasted a cigarette earlier even if they did not smoke at the time of the survey.

(*b*) The results show smoking habits among school children only. Most probably the frequency of smokers is higher in the total population of young people than in the school population and this difference increases with increasing age.

(*c*) The results show the smoking habits only of those who were aged from 14 to 19 years *in 1957*. There is a clear tendency from year to year to start smoking at an earlier age.

The frequency of smokers in our survey therefore under-estimates the real frequency, especially with regard to the future, *i.e.* if the trend continues to be as before. This fact should make the results from our survey more convincing and emphasize the seriousness of the problem.

Returning to the difficulties of making an adult habitual smoker stop smoking, it should be clear that the most effective preventive work against lung cancer can be done among those who have not yet become habitual smokers. Our survey has shown



that it is usually at the age of 13 to 18 years that smoking becomes habitual. This has been the case with the present adult smokers and it is true to a greater degree with young people nowadays. Educational preventive work should therefore begin at about 13 years of age and continue to about 18 years of age when the greatest danger of becoming a habitual smoker is over.

I am indebted to the Norwegian Cancer Society's Committee on the Smoking Habits of Young People (Chairman: Chief Physician Fredrik Mellbye) for valuable aid in designing the survey, and especially to chief physician Einar Pedersen for reading and commenting on the manuscript.

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AIR POLLUTION AND CAUSES OF DEATH

BY

CHARLES DALY

Ulverston, Lancs.

This paper describes a study of the relationship between indices of air pollution and respiratory and other causes of death in the large towns of England and Wales.*

Although there are now well over a thousand instruments measuring air pollution in one way or another in England and Wales, grave difficulties are involved in using their results to measure the average exposure to pollution experienced by the inhabitants of any given town. Many instruments, for instance, have deliberately been sited near known sources of pollution to measure changes in the level of pollution over the years; and few towns have many instruments—Liverpool, for example, had only two in 1954 (Department of Scientific and Industrial Research, 1955)—and there is often considerable variation in the levels indicated.

An attempt has therefore been made to find some better and more meaningful measure of the degree of air pollution to which the inhabitants of any town have been exposed. The indices adopted were based on the quantities of different fuels burnt annually in each town, and the area in which they are burnt.

The 83 county boroughs (C.Bs) of England and Wales were chosen for study because details of the numbers of deaths in these towns have been published or otherwise made available by the General Register Office over a considerable period; 79 of them are in England, and four in Wales, and they vary in size from Canterbury with a population of 28,000, to Birmingham with a population of over one million, the average (median) being about 110,000.

Six groups of causes of death have been studied:

(1) Bronchitis
(2) Pneumonia
(3) Respiratory Tuberculosis
(4) Lung Cancer
(5) Other Respiratory Diseases
(6) All Non-Respiratory Diseases.

The standard of diagnosis of these diseases may vary in different parts of the country, but it is felt that this is unlikely to invalidate the results obtained. Any relationship between the "social status" of a town and the diagnostic criteria adopted by its doctors has been taken into account to some extent in the statistical techniques used in the study of social indices. The death rates refer almost entirely to males in the age group 45–64 years and cover the 7-year period, 1948–54. Death rates for the age group 65–74 years refer to the 5-year period 1950–54, since the figures available were less detailed before 1950. The populations on which the various rates are based are those of the 1951 Census. Details of these death rates have been published by the General Register Office (1957).

Measurement of Fuel Consumption

Data on the consumption of different types of fuel in the 1,330 local fuel overseer (L.F.O.) areas were published by the Ministry of Fuel and Power (1955). Since most of the county boroughs were complete L.F.O. areas, the required statistics were readily available and access to much unpublished data permitted reasonable estimates to be made of the amount of different types of fuel consumed in each town in, or about, the year May, 1951 to May, 1952. The *domestic* fuels are house coal, coke, anthracite, and boiler fuel, and the *industrial* fuels are smokeless solid fuel, other solid fuel, and liquid fuels (*i.e.* gas/diesel oil, fuel oil, and creosote/pitch mixture).

* Most of this work was done while the author was a member of the staff of the Social Medicine Research Unit of the Medical Research Council.

Details of the fuel consumed by the electricity generating stations were also available, but this has not been classed here as "industrial" fuel, the question of air pollution by power stations being dealt with separately. It was unfortunately impossible to obtain any information about air pollution by railways and shipping. (For details of these statistics and methods used to make certain estimates, see Appendix.)

One aim of the inquiry was to differentiate between the effects of smoke and sulphur pollution, and for this purpose the Fuel Research Station of the Department of Scientific and Industrial Research supplied estimates of the amounts of smoke and sulphur dioxide emitted by given quantities of each of the fuels mentioned above. The amount of smoke and sulphur dioxide emitted annually in each C.B. was then estimated on this basis.

Measurement of Area

The area of a town in which fuel is burnt is the "built-up area". In a previous communication of preliminary results (Daly, 1954), use was made of the *total* area of each C.B., though it was pointed out that these areas often include considerable portions of agricultural or park land. Subsequent studies showed a great range of variation in the proportion of a town's area which is "built-up". Smethwick, for example, is completely built-up, (according to the definition given below), whereas more than 14,000 of Merthyr Tydfil's 17,760 acres do not appear to be built on at all.

Since no data existed on the exact proportion of built-up area in each C.B., a separate inquiry was undertaken to obtain the relevant information. The Ministry of Housing and Local Government gave access to the 6 in. to the mile maps of present land utilization which had been submitted by each county borough under the Town and Country Planning Act, 1947. Details of the techniques involved in delineating the requisite areas are given in the Appendix, but it can be mentioned here that the work was carried out independently by a geographer, W. T. W. Morgan, B.A., M.Sc. To reach the required figure, built-up areas were defined as all industrial areas, together with residential areas, comprising as a minimum requirement "detached or semi-detached houses with large gardens. Excluded are those areas with detached houses having gardens of more than one-third of an acre, usually not fronting a road."

Measurement of Air Pollution

In towns of the same built-up area, it is reasonable to assume that there is a direct relationship between the amount of fuel burnt and the level of air pollution. The amount of smoke emitted annually per acre of built-up area was therefore taken as an index of a town's pollution by smoke. A similar procedure gave an index of sulphur pollution, but it was found that these two indices were so highly correlated in the 83 C.Bs, that it was impossible to differentiate between their respective effects, if any. For this reason results for only one set of indices (*i.e.* domestic smoke and industrial smoke) are presented and the indices have been termed "domestic pollution" and "industrial pollution".* (For values of these indices for each C.B., see Appendix.) The two indices have not been amalgamated to give some general measure of air pollution, since the relationship between each index and the various causes of death seems to differ. On *a priori* grounds, also, it is not unreasonable to keep the two measures separate. For example, industrial chimneys are not so evenly spread throughout a town as domestic chimneys and the measure of their coal consumption per acre of built-up area may, therefore, be less meaningful. Further, industrial chimneys are very much higher, so that a much greater proportion of their emission is probably dispersed into the atmosphere. It follows that the "arbitrary units" adopted in this paper can validly be used in comparisons between towns but must not be taken to demonstrate the relative magnitudes of the domestic and industrial air pollution effects.

Although a study of domestic and industrial fuel consumption fails to indicate the relative importance of the effects of smoke and sulphur emission on health (as measured by mortality rates), it has been possible to study the problem in another way. Power stations are essentially sulphur-emitting agents, and if pollution from this source is shown to have an effect on health then sulphur would probably be incriminated. Since they are point sources of pollution, however, the techniques used for measuring domestic and industrial pollution are inapplicable. This particular problem is approached by a different method which is outlined later.

Correlation.—In correlating the indices of pollution with the death rates, one important feature must

* For reasons which will be discussed later the logarithm of industrial smoke per acre has been used as the "industrial pollution" index in the calculation of correlation co-efficients.

be mentioned. When any variables are subject to sampling error, the correlation co-efficient tends to underestimate the true relationship between the two characteristics. Technically, it is said to be "attenuated". Death rates in a town vary from year to year, and even rates based on 7-year data are only estimates of some hypothetical death rates. This fact has had to be taken into account in the results which follow, since six causes of death are dealt with, each affected by attenuation error to a varying extent. When bronchitis death rates are involved, the corrected value of r is 3 per cent. greater than the calculated value; for pneumonia the corresponding figure is 16 per cent.; for respiratory tuberculosis 9 per cent.; for lung cancer 12 per cent.; for other respiratory diseases 29 per cent.; and for all non-respiratory diseases 5 per cent.* It should be noted, however, that these values may still be under-estimates, since they do not take into account any diagnostic error.

There is no doubt that the air pollution indices are also subject to considerable error, but it is impossible to measure the extent of this, and no attempt has been made to correct the relevant values of r. The same applies to the various social indices studied; these are probably imperfect measures of some underlying "social factor", but how imperfect they are is unknown.

Effects of Domestic and Industrial Air Pollution

The basic results are presented in Table I, which shows a high correlation between domestic air pollution and five of the six groups of causes of death, including the non-respiratory diseases.

Table I

ASSOCIATION BETWEEN INDICES OF DOMESTIC AND INDUSTRIAL AIR POLLUTION AND DEATH RATES FROM CERTAIN CAUSES IN THE 83 COUNTY BOROUGHS OF ENGLAND AND WALES, MALES AGED 45–64 YEARS; 1948–54

Cause of Death	Air Pollution	
	Domestic	Industrial
Bronchitis	0·70 (0·68)	0·62 (0·60)
Pneumonia	0·60 (0·52)	0·52 (0·45)
Respiratory tuberculosis	0·59 (0·54)	0·22 (0·20)
Lung cancer	0·54 (0·48)	0·20 (0·18)
Other respiratory diseases	0·27 (0·21)	0·01 (0·01)
All non-respiratory diseases	0·50 (0·48)	0·35 (0·33)

Values of the correlation co-efficient r corrected for attenuation error.
Uncorrected values are given in brackets.

* It is hoped to publish a paper describing the mathematical treatment of this problem in due course.

Bronchitis shows the highest degree of association, followed by pneumonia, respiratory tuberculosis, lung cancer, and all non-respiratory diseases—in that order—all showing a substantial association with domestic pollution. Other respiratory diseases show the least close association. Industrial pollution shows a clear association with bronchitis and with pneumonia, rather less with the non-respiratory diseases, and no significant degree of relationship with tuberculosis, lung cancer, and other respiratory diseases.

Bronchitis and lung cancer are probably of most interest here, and Figs 1 and 2 (opposite) present graphically the associations between these causes of death in middle-aged males and the two pollution indices. Bronchitis shows a clear upward trend with domestic air pollution, those towns with low pollution having low rates, and those towns with high pollution tending to have the highest rates. With cancer of the lung there is a slight upward trend, but it is clear that domestic air pollution cannot account for much of the differences in the death rates between the various towns.

Fig. 2 picks out three towns (St. Helens, Middlesbrough, and Stoke-on-Trent) with exceptionally high indices of industrial air pollution (as measured here). Their bronchitis death rates, however, are not correspondingly high—being only a little above the average. The inclusion of these towns in the calculation of the correlation co-efficient would have a disproportionate effect, and the logarithm of "industrial smoke per acre" has therefore been used as the index of industrial air pollution. This procedure is not applied without precedent, since one is accustomed in biological work to encounter "dose-response curves" in which there is a linear relation between the response and the logarithm of the dose. It is worth noting that the co-efficient measuring the correlation between the bronchitis death rates and the logarithm of the industrial air pollution index is very similar to that obtained when the same death rates are correlated with the unadjusted index of air pollution for all the C.Bs excluding the three already mentioned. Fig. 2A shows a clear upward trend, but Fig. 2B shows only a slight trend.

Occupational Factors

Before further discussing the various features of Table I, some mention should be made of the group of "other respiratory diseases". This miscellaneous group may sometimes include many deaths due to occupational hazards:–Stoke-on-Trent and Merthyr Tydfil have rates of 89 and 131 per 100,000 respectively, while no other town has a rate greater than

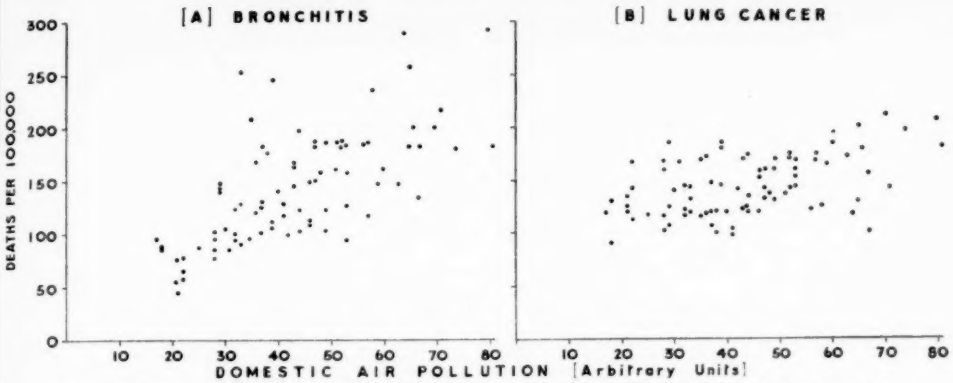

FIG. 1.—Death rate per 100,000 males aged 45 to 64 years from (A) Bronchitis and (B) Lung Cancer related to air pollution in 83 county boroughs.

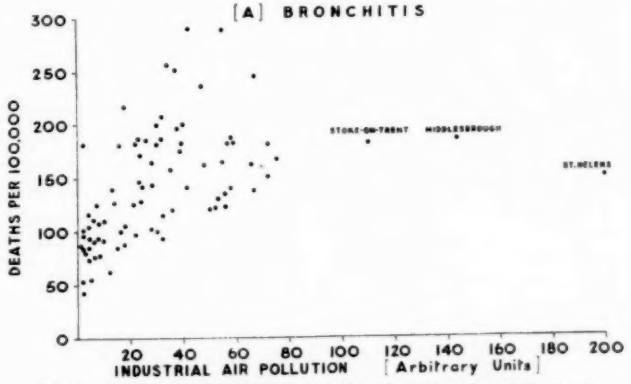

FIG. 2A.—Death rate per 100,000 males aged 45 to 64 years from bronchitis related to industrial air pollution in 83 county boroughs.

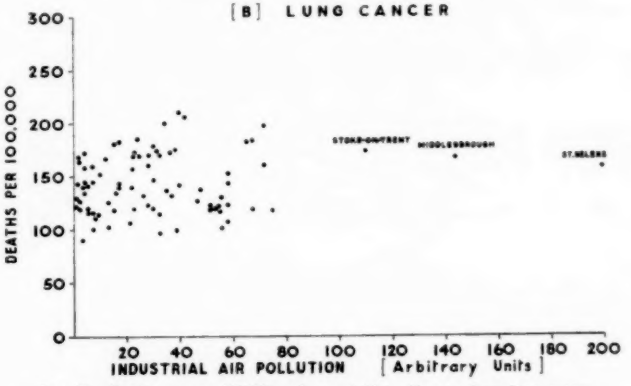

FIG. 2B.—Death rate per 100,000 males aged 45 to 64 years from lung cancer related to industrial air pollution in 83 county boroughs.

50 per 100,000. These figures presumably reflect the incidence of silicosis among potters, and of pneumoconiosis among coal miners. In view of this, it is necessary to bear in mind that the rates for "other respiratory diseases" may be distorted by occupational differences between the populations in each town.

That occupational differences probably have little effect on the male death rates from bronchitis is demonstrated by Fig. 3, which compares male and female mortality from bronchitis at ages 45–64 years. With the exception of Oldham and to a lesser extent Bolton, Bury, and Burnley, the points on the scatter diagram all lie very near to a straight line, indicating that the ratio of the male to the female death rate (about 4:1) is approximately the same in each C.B. As far as the four Lancashire towns are concerned, it is not unreasonable to suggest that an occupational factor affects the female cotton workers particularly in Oldham. This is in agreement with some of the work of Schilling (1956) on byssinosis in Oldham.

A similar technique cannot be applied to the comparison of male and female mortality from lung cancer, since the female death rates are based on relatively small numbers of deaths and liable to considerable error. Alternative methods of statistical analysis (Woolf, 1955) do show, however, that after taking these errors into account the ratio of male to female death rates in each town could be constant. (Bury may be a possible exception to this, since in the period studied 5·77 female deaths were to be expected, whereas fifteen actually occurred.)

Influenza Epidemics

Because epidemics of influenza affect the recorded bronchitis death rates it was thought worthwhile to examine the statistics to see whether this had been important in the period studied—which includes two "flu" years. Ten C.Bs were chosen at random and the numbers of deaths from bronchitis in each town were tabulated for each year separately. A test was then carried out to see if the pattern of deaths between the towns varied from year to year. The resulting value of $\chi^2 = 60{\cdot}77$, 54 d.f. ($P = 0{\cdot}25$) gave no grounds for believing that the inclusion of these "flu" years had noticeably disturbed the pattern of the bronchitis death rates.

Other Factors

The chief feature of Table I is the importance of the relationship between both indices of air pollution and the bronchitis death rates. When the combined "effects", of the pollution indices are considered (using the technique of multiple correlation), it is found that they could together account for about 60 per cent. of the existing variation in the death rates between towns. (Since the pollution indices are subject to error, it is probable that this value is an underestimate.) However, no account has yet been taken of the fact that the 83 C.Bs differ greatly in many ways apart from air pollution. The extent of overcrowding, the social structure, and the temperature, humidity, and other climatic factors are all variable. It is impractical for every possible factor to be taken into account, but data from the 1951 Census give indications of the "social" differences. As far as climatic effects are concerned, though the C.Bs on Tyneside compare unfavourably with those on Merseyside and near Manchester as far as temperature* is concerned, they have lower death rates from bronchitis.

For topographical reasons, some towns have more natural fog than others and are therefore more liable to episodes of "smog". It has not been possible, however, to take this into account.

* Tyneside also compares unfavourably with Merseyside and Manchester with regard to overcrowding.

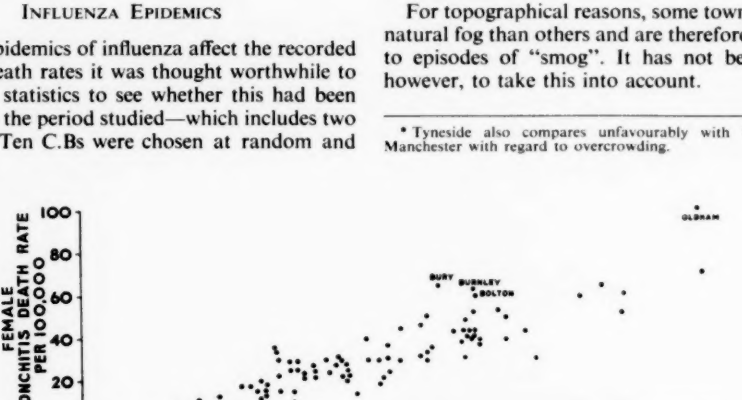

FIG. 3.—Male and female death rates per 100,000 persons aged 45 to 64 years in 83 county boroughs.

Towns also differ in the amount of air pollution received from external sources. Apart from emissions from its own chimneys, a town such as Bootle must receive pollution from those of its neighbour Liverpool, whereas a town such as Norwich is relatively unaffected by pollution from other areas. To test whether the nature of the surrounding area introduced any bias to the results, the sixteen C.Bs completely surrounded by rural areas were studied. Although these include Warrington, situated between, and only a few miles from, the Manchester and Merseyside "conurbations" the degree of relationship between bronchitis mortality and domestic air pollution is still high—$r = 0{\cdot}55$. (A similar figure is obtained when Warrington is excluded from the analysis.)

Table II shows the association between the death rates and four social indices: (*a*) "social class" structure; (*b*) overcrowding; (*c*) population density; and (*d*) education.

Calculation of Indices. (For the values for each C.B. see Appendix):

(*a*) Using the Registrar General's classification of occupations (General Register Office, 1951), and 1951 Census data on the proportions of the five social classes so defined which were to be found in the C.Bs, a score of 1 to 5 was assigned to each of the social classes and a weighted average score was obtained for each C.B.† They ranged from 2.90 in Bournemouth to 3·64 in Bootle.

(*b*) The index of overcrowding adopted was the proportion of households living more than one person per room. It ranged from 8·1 per cent. in Great Yarmouth to 34·9 per cent. in Gateshead.

(*c*) From the point of view of spread of infection it may be argued that people living in towns with a high density of population (measured by the number of persons per acre) are more liable to respiratory diseases than people living in towns with a lower density. But any measure of density obtained by dividing the total population by the area of a town is obviously highly correlated with domestic air pollution. The following procedure was used to obtain a more meaningful measure of population density, and one which is less highly related to air pollution, so that it is easier to distinguish between the effects, if any, of both of these factors.

Besides the maps of present land utilization at the Ministry of Housing and Local Government already described, there exist certain statistics about land use, such as the population densities in a number of "areas of similar development" within each town. (These areas might comprise a new council housing estate, or several streets of terraced houses, and so on.) The average (median) of these densities has been taken as the required measure. For instance, the median population density of Stoke-on-Trent is 48·6 persons per acre, which means that half the population live at a lower population density and half at a higher density. The values obtained for the 83 C.Bs ranged from 21·3 persons per acre in Bournemouth to 87·6 persons per acre in Bootle.

(*d*) The proportion of occupied males in any town who left school before the age of 15 years was used as a measure of differences in education. The proportion ranged from 64·5 per cent. in Plymouth to 87·5 per cent. in Stoke-on-Trent and Warrington.

† Similar results were obtained using "the proportion in Social Classes IV and V".

Bronchitis

Table II shows that with bronchitis the correlation co-efficients are about the same level for the social indices as for the air pollution indices. The highest degree of association appears to be with "educational level" and the lowest, surprisingly, with "population density", but all four social indices are highly inter-related, and it is likely that they are

TABLE II

ASSOCIATION BETWEEN FOUR "SOCIAL" INDICES AND DEATH RATES FROM CERTAIN CAUSES IN THE 83 COUNTY BOROUGHS OF ENGLAND AND WALES. MALES AGED 45–64 YEARS: 1948–54

Cause of Death	Social Indices			
	Social Class	Overcrowding	Population Density	Education
Bronchitis	0·64 (0·62)	0·50 (0·48)	0·47 (0·46)	0·73 (0·71)
Pneumonia	0·63 (0·54)	0·51 (0·44)	0·47 (0·40)	0·44 (0·38)
Respiratory tuberculosis	0·49 (0·45)	0·64 (0·59)	0·47 (0·43)	0·31 (0·28)
Lung cancer	0·38 (0·34)	0·48 (0·43)	0·45 (0·40)	0·21 (0·19)
Other respiratory diseases	0·28 (0·22)	0·11 (0·09)	0·02 (0·02)	0·16 (0·12)
All non-respiratory diseases	0·34 (0·32)	0·31 (0·30)	0·37 (0·35)	0·27 (0·26)

Values of the correlation co-efficient r corrected for attenuation error.
Uncorrected values are given in brackets.

simply different aspects of a certain factor which in some very complex way, can be thought of as measuring social differences between towns.

While clearly it would be desirable to analyse the data so as to be able to state that a certain proportion of the variation in the bronchitis rates was due to air pollution, and another proportion to social factors, this is not possible with any reasonable degree of precision. Broad conclusions can, however, be drawn. When bronchitis mortality is correlated with domestic and industrial air pollution, and the "effects" of social factors (assuming these to be direct effects) are eliminated,* a correlation co-efficient $r = 0{\cdot}47$ is obtained. When bronchitis mortality is correlated with "social" factors, and the "effects" of air pollution (assuming now that these are direct effects) are eliminated, we obtain $r = 0{\cdot}39$. Both these values are highly significant, indicating that air pollution and social factors have an independent and real effect, and in view of the similarity of these correlation co-efficients, it is not unreasonable to infer that these effects are of similar magnitude. Since it can be shown that about two-thirds of the variation in the bronchitis death rates could be attributed to the combined effects of air pollution and social factors (as measured), it follows that about one-third of the variation in mortality could be attributed to air pollution and about one-third to social factors. In view of the imperfections of the indices used, it is likely that these proportions are under-estimated, but it is not possible with the material available to determine the reasons for the residual third of the variation in mortality.

It can be noted that, in the London area, the Metropolitan Borough with the lowest bronchitis death rates for males aged 45–64 years or 65–74 years is Chelsea, which has both a high "social status"† *and* an above average level of air pollution —(and incidentally, several large power stations in the near vicinity). It could be inferred from this that air pollution is less important than social factors. However, even if air pollution is implicated in only 30 per cent. of all bronchitis deaths in England and Wales, this is equivalent to more than 7,500 deaths in any one year.

Lung Cancer

Table I and Figs 1 and 2 have shown that the relationship between lung cancer deaths and air pollution is less than that between bronchitis deaths and air pollution. As far as the present indices are concerned, only about 35 per cent. of the variation in lung cancer mortality between the towns could be attributed to the combined effect of both pollution and social indices. A co-efficient of $r = 0{\cdot}31$ is obtained when the death rates are correlated with air pollution after eliminating the effects of the social indices, and a co-efficient of $r = 0{\cdot}25$ when they are correlated with social indices after eliminating the effects of air pollution. There is, therefore, no indication here that air pollution is a major factor in the aetiology of lung cancer. The fact that domestic air pollution demonstrates a rather higher correlation with this cause of death than does industrial air pollution may be relevant to the hypothesis that the benzpyrene in town air is an aetiological agent; Waller (1952), who made measurements in various towns, expressed the opinion that most of this benzpyrene derived from domestic fires.

If only 35 per cent. of the difference in the lung cancer death rates between county boroughs can be ascribed to differences in air pollution or to "social" differences, can the remainder be ascribed to differences in smoking habits between the towns? In an attempt to answer this question, the results of a market survey study by Research Services Ltd. have been used. Their data cover the period August, 1952, to December, 1955. Using the technique of quota sampling, men and women of different ages were interviewed in almost every administrative area in England and Wales and their smoking habits discussed. The following results were confined to males aged 45–64 years. Only one county borough (Dewsbury) was missed in this study. Some of these towns are relatively small, and consequently had few interviews. It was decided therefore to split the towns into eight groups—the first group of eleven towns comprising those with the lowest lung cancer rates for males aged 45–64, and the last group of ten towns comprising those with the highest rates. The results are summarized in Table III (opposite).

There is a considerable range of variation in the lung cancer rates, Group 1 having an average rate of 106 per 100,000 while Group 8 has an average rate of 191 per 100,000. The trend in the death rates is not, however, repeated to any marked extent in the various indices of smoking habits. As far as the proportions of non-smokers and cigarette smokers only are concerned, there is little indication that the average amount smoked varied very much from one group of towns to another. (This was also the case for males aged 65-74 years.) At the most, if we consider the number of cigarettes smoked per male in these groups of towns, we get an increase of about

* Using the "combined partial correlation co-efficient" described by Stouffer (1934). Only two social indices have been used—those giving the highest values of r. The addition of the others has a negligible effect.

† This is equivalent to a *low* social index on the scale described.

TABLE III

DIFFERENCES IN SMOKING HABITS IN EIGHT GROUPS OF COUNTY BOROUGHS, CLASSIFIED IN ORDER OF INCREASING MALE LUNG CANCER DEATH RATE IN 1948–54 MARKET RESEARCH SURVEY DATA OBTAINED BY RESEARCH SERVICES LTD. (AUG. 1952 TO DEC. 1955) FOR MALES AGED 45–64 YEARS

Group	No. of County Boroughs	Number of Persons Interviewed	Non-Smokers		Cigarette Smokers		All Smokers		Average Lung Cancer Death Rate
			Number	Per cent.	Number	Average Number of Cigarettes Smoked†	Number	Average Quantity of Cigarette Equivalents Smoked†	
1	11	261	52	19·9	174	14·7	209	16·7	106
2	11	186	46	24·7	122	15·2	140	17·6	118
3	10	201	35	17·4	145	15·4	166	17·4	125
4	10	235	49	20·9	162	15·0	186	17·6	137
5	19	327	62	19·0	228	16·8	265	17·5	147
6	10	395	69	17·5	288	14·2	326	17·8	162
7	10	768	178	23·2	523	16·5	590	18·1	171
8	10	514	86	16·7	381	16·8	428	18·3	191

†These figures refer to quantities smoked on the day previous to the questionnaire.

18 per cent. related to a 63 per cent. increase in the lung cancer death rate.

It may be of course, that an index of present smoking habits is inadequate and that a measure of smoking habits 30 years ago is more relevant here. This may be so; but to explain away the differential in lung cancer death rates between towns in terms of smoking habits would imply that substantial changes had taken place in the smoking habits of the populations in whole groups of towns. Also, the "proportion of non-smokers" is not tied down to any consideration of the previous day's smoking habits. It seems likely, therefore, that neither differences in domestic or industrial air pollution, in smoking habits, or in social factors, can account for more than a relatively small proportion of the variation observed in the death rates for lung cancer in the various county boroughs.*

In seeking for some other factor which could be responsible for this variation, a number of analyses were carried out. One interesting result which emerged was the fact that lung cancer seemed to be highly related to respiratory tuberculosis, in so far as those towns with a high death rate from one disease tended also to have a high death rate from the other. The relevant value of r is 0·66 (a value which is not altered when social class is taken into account), whereas $r = 0{\cdot}41$ in the comparison of lung cancer with bronchitis, and $r = 0{\cdot}27$ in the comparison of lung cancer with pneumonia. If it be postulated that people who have had a certain degree of respiratory tubercular infection are more liable to lung cancer, then the variation between towns in the lung cancer death rate could be attributed, in part at least, to the fact that some towns contained a greater proportion of such people than others—which is highly probable in view of the large variation between these towns in mortality from respiratory tuberculosis. However, it has not been possible to follow up this idea in detail.

Table IV shows a puzzling feature of the data. When the "density aggregates" are studied, a clear trend from rural area to conurbation is discernable for lung cancer but such a trend is practically non-existent for "all non-respiratory diseases". It is partly on the strength of such tables that air pollution has been hitherto considered to be a possible important factor in the aetiology of lung cancer. When the 83 C.Bs are classified according to density aggregate in this way, a similar trend appears for lung cancer but not for the non-respiratory diseases. Yet Table I shows that, on the whole, there

TABLE IV

THE VARIATION IN CERTAIN DEATH RATES BY DENSITY AGGREGATES. MALES AGED 45–64 YEARS, ENGLAND AND WALES, 1950–52

(DEATH RATES PER 100,000—RURAL AREAS ALSO TAKEN AS 100)

Cause of Death	All Conurbations	Urban Areas‡			Rural Areas
		Large	Medium	Small	
Bronchitis	153	129	112	100	59
	259	**219**	**190**	**169**	**100**
Pneumonia	52	54	42	38	30
	173	**180**	**140**	**127**	**100**
Respiratory tuberculosis	89	90	76	68	47
	189	**191**	**162**	**145**	**100**
Lung cancer	159	147	125	113	86
	185	**171**	**145**	**131**	**100**
Other respiratory diseases	25	33	26	32	27
	93	**122**	**96**	**119**	**100**
All non-respiratory diseases	1,067	1,091	1,063	1,055	904
	118	**121**	**118**	**117**	**100**

* It does not follow from this that there is no relation between smoking and lung cancer in individuals. It implies that smoking cannot be the only factor in the aetiology of lung cancer.

‡The large, medium, and small urban areas have populations greater than 100,000, between 50,000 and 100,000, and below 50,000 respectively.

is rather less correlation between air pollution and lung cancer than between air pollution and non-respiratory diseases. It would appear from these facts that lung cancer is related in some way to the size of the town, though it is difficult to see how. This has been confirmed by a study of the mortality rates in the 83 C.Bs, which showed a significant association between population and lung cancer mortality but practically none between population and respiratory tuberculosis mortality.

One final point worth bearing in mind before the density aggregates are used to draw conclusions about the effects of air pollution is that the large urban areas (those with a population of 100,000 or more—outside the conurbations) include such relatively non-polluted towns as Blackpool, Bournemouth, Norwich, and Southend.

Other Causes of Death

One interesting feature of Table I insofar as causes of death other than bronchitis and lung cancer are concerned, is the relatively high correlation between air pollution and all non-respiratory diseases. Neither lung cancer, respiratory tuberculosis, nor other respiratory diseases show any significant correlation with industrial air pollution, yet with the non-respiratory diseases $r = 0{\cdot}35$. Although four of the causes of death studied showed closer relationships with domestic air pollution, the value of $r = 0{\cdot}50$ obtained by correlating with the non-respiratory diseases is very highly significant. One possible explanation is that "good health" is being measured here, and that this is associated with exposure to sunshine, which, in towns, is considerably reduced by air pollution. When the non-respiratory diseases are correlated with both pollution indices, after eliminating the effects of the two main social indices, a value of $r = 0{\cdot}35$ is obtained, which is still relatively high.

Pneumonia shows much the same tendencies as bronchitis, and the relevant correlation co-efficients in Tables I and II are very similar. However, when pneumonia is correlated with both pollution indices, after eliminating the effects of social factors, $r = 0{\cdot}28$ which is very much less than the corresponding figure of $0{\cdot}47$ for bronchitis.

Respiratory tuberculosis shows some correlation with domestic air pollution but little with industrial air pollution. As one would expect, it is most highly associated with overcrowding. When correlated with air pollution, after eliminating social factors, $r = 0{\cdot}33$.

Other respiratory diseases do not appear to be correlated with any of the indices studied.

Air Pollution by Power Stations

It has already been remarked that it was impossible to differentiate between the effects of smoke and the effects of sulphur in considering pollution from domestic and industrial sources. A special study was therefore made of power stations, since they are primarily sulphur-producing agents and any harmful effects attributed to them would probably be due to their emission of sulphur products. Unlike domestic chimneys, which are spread fairly evenly throughout a town, power station chimneys can be thought of as point sources of pollution, and the concept of fuel consumed per acre of built-up area is therefore irrelevant. Instead, a detailed study was made of each county borough to find out (*a*) the proportion of the population living within one mile of a power station, (*b*) the average amount of sulphur emitted by each station over a period of 11 years, and (*c*) the heights of the chimney stacks. These were combined in a number of ways to give measures of what might be described as the potential "nuisance value" of the power stations in or near the 83 C.Bs. The results obtained did not indicate that proximity to a power station increases the death rate from bronchitis. For instance, Fig. 4 shows that C.Bs with no power stations (eight had no power station within a mile) have just as high an average bronchitis death rate as those with a very high level of power station pollution. The "nuisance value" index in this case was based on the product of (1) the average annual sulphur emission during the 11 years, 1941–51, (2) the proportion of the population living within one mile of a power station, and (3) the inverse of the average chimney height (taking 100 ft. as the minimum, since diffusion

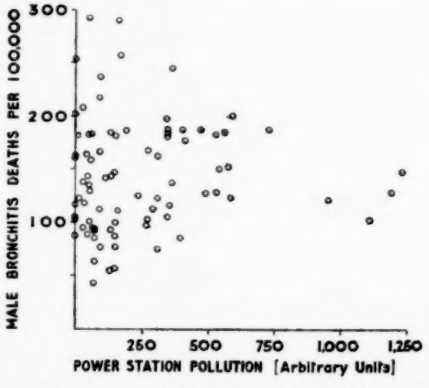

Fig. 4.—Death rate per 100,000 males aged 45 to 64 years from bronchitis related to power station pollution in 83 county boroughs.

effects will probably be similar below that height). No greater correlation was obtained when various other combinations of these factors were studied. Admittedly, this is an indirect method of measuring power-station pollution, but in considering as many as 83 towns, it is not unreasonable to expect some trend to be apparent if an effect really exists. This work confirms some recent conclusions that power stations make no appreciable difference to the levels of sulphur dioxide in a built-up area (Jarvis and Austin, 1957).

SUMMARY

Indices of air pollution from domestic and industrial sources in the 83 county boroughs of England and Wales have been calculated, using information about fuel consumption in defined built-up areas. These indices have been correlated with death rates from various respiratory and other diseases among middle-aged males. The results show a relatively close association between these measures of air pollution and bronchitis, and a relatively low association between air pollution and lung cancer. Allowance for social class differences between towns reduces but does not abolish the correlation with bronchitis mortality. Various hypotheses for the variations in mortality are put forward.

An attempt has been made to measure the effect of air pollution from sulphur products by studying the power stations in or near each town. The results give no reason to suppose that proximity to a power station has any noticeable effect on bronchitis mortality.

This study has been made possible by the help and co-operation of many organizations, including the General Register Office, the Ministry of Fuel and Power, the House Coal Distribution (Emergency) Scheme, the Fuel Research Station of the D.S.I.R., the Ministry of Housing and Local Government, the Central Electricity Authority, the Gas Council, the Tobacco Manufacturers' Standing Committee, and the Royal Geographical Society. I should also like to thank Mr. W. T. W. Morgan who gave most invaluable help in calculating the built-up areas, Dr. J. N. Morris and Mr. J. A. Heady for much advice, and Mrs. V. Hall for most of the work of computation.

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APPENDIX

FUEL CONSUMPTION DATA.—The sources of data were as follows:

Domestic

(1) HOUSE COAL

(*a*) *Distributed by Merchants.*—These data, referring to distribution in "house coal districts", were obtained from the weekly returns of the House Coal Distribution (Emergency) Scheme;

(*b*) *Distributed as Miners' Concessionary Coal.* No direct data were available about the distribution by the National Coal Board of miners' coal in each county borough, but the General Register Office made Census material available concerning the number of miners in each town. By multiplying by the average amount of coal received annually by each miner, the required estimates were obtained.

(2) COKE

(*a*) *Distributed by Merchants.*—As for 1(*a*).

(*b*) *Distributed directly by Gasworks.*—The Gas Council supplied rough estimates for each county borough.

(3) ANTHRACITE AND BOILER FUEL.—Distributed by merchants, as for 1(*a*).

Industrial

(1) Data referring to consumption in local fuel overseer areas of both smokeless and other solid fuels were obtained from the Ministry of Fuel and Power's Statistical Digest for 1954.

(2) Data for liquid fuels (gas/diesel oil, fuel oil, and creosote-pitch mixture) were obtained partly from the same source, and partly from the more detailed records of the Ministry of Fuel and Power.

All these data refer to county boroughs, house coal districts, and local fuel overseer's areas. These do not coincide, but a practical example shows how comparable statistics were obtained for one county borough—the basic unit of area, since the death rates are based on the populations living in each county borough.

In the year May, 1951, to May, 1952, the period to which most of the fuel consumption statistics refer, the merchants in the "house coal district" of Gloucester supplied 51,756 tons of house coal to 35,060 registered premises. This is equivalent to 1·4762 tons per registered premise.

The relevant L.F.O. area comprises Gloucester county borough and Gloucester rural district, and only their total number of registered premises is known, in this case 37,156. The 1951 Census data showed that there were 18,952 households in the C.B. and 8.904 in the rural district. On the whole, the number of registered premises is proportional to the number of households so calculation gives:

$$37{,}156 \times \frac{18{,}952}{(18{,}952 + 8{,}904)} = 25{,}281 \text{ households}$$

in the county borough as the estimate. It was assumed that these households received the same average quantity of house coal as the 35,060 served by the merchants, giving as a final estimate 25,281 × 1·4762 = 37,320 tons of house coal consumed in the county borough of Gloucester.

A similar procedure was carried out for coke and anthracite, and boiler fuel distributed by merchants, and it was estimated that 6,558 tons of coke and 3,153 tons of anthracite or boiler fuel were also consumed in the county borough in the stated period.

About 4,200 tons of coke were distributed by gasworks to "domestic and other users", and as the proportion going to "domestic users only" was about 33 per cent. in the whole South-Western region, it was assumed that 33 per cent. of 4,200 = 1,400 tons were consumed by domestic users in the county borough. The remaining 2,800 tons were included in the industrial fuel statistics.

The number of miners living in Gloucester at the time of the 1951 Census being negligible, the estimation of miners' concessionary coal is best illustrated by a town such as Doncaster, which then contained 2,273 miners aged 15–64 years.

The 612,400 such miners in the whole of England and Wales received a total of 5,200,000 tons of concessionary coal in 1951/52, so that

$$2{,}273 \times \frac{5{,}200{,}000}{612{,}300} = 19{,}300 \text{ tons}$$

may be taken as the amount of coal consumed by miners in this county borough.

Although most of the county boroughs comprised complete L.F.O. areas, some of them had been amalgamated with one or more urban or rural district to form a single L.F.O. area. Since the industrial coal statistics only applied to the latter, it was necessary to make some estimate of the proportion of industrial fuel consumed in the C.B. itself. This was done by using data supplied by the Ministry of Housing and Local Government on the rateable value of industrial hereditaments in each county borough, urban district, and rural district.

For example, Gloucester L.F.O. area consists of Gloucester C.B. and Gloucester R.D., in which the rateable value of the industrial hereditaments were respectively £16,376 and £19,796. Since 77,400 tons of non-smokeless solid fuel were used by industrial consumers in the L.F.O. area, those in the C.B. presumably used

$$77{,}400 \times \frac{16{,}376}{(16{,}376 + 19{,}796)} = 35{,}039 \text{ tons.}$$

A similar procedure was carried out for the other industrial fuels.

Finally, when the fuel used by carbonization and briquetting plants (*i.e.*, gas works, coke ovens, etc.), is burnt, only a small proportion of the products of combustion are released to the atmosphere. The Beaver Committee (1954) shows, for instance, that 27·2 million tons of fuel were supplied to gas works in 1953, but that only 6·2 million tons of fuel were burnt. Allowance has therefore been made for this effect, though results are complicated by the fact that the fuel burnt in coke ovens consists of a gas. The resulting figures have been included in the indices of "industrial air pollution".

MEASUREMENT OF BUILT-UP AREAS.—The Ministry of Housing and Local Government gave access to the 6-in. to the mile maps of present land utilization which had been submitted under the Town and Country Planning Act, 1947, by each county borough and a number of other towns. These maps have been based on surveys made between 1947 and 1952, most of them being completed between 1949 and 1951. The following procedure was adopted—all work being carried out independently by Mr. W. T. W. Morgan.

The industrial and residential areas were traced out in each town, the minimum qualification for a "residential" area being defined beforehand as "detached or semi-detached houses with large gardens. Excluded are those areas with detached houses having gardens of more than one-third of an acre usually not fronting a road". A line was then drawn on the map at an arbitrary distance of half an inch round these areas to eliminate subjective judgment in deciding whether an embayment of open land should be included in the built-up area or whether a detached portion of the town was far enough away to require separate consideration. A similar procedure in reverse determined how much of a large park or waste area in the middle of a town should be included in the built-up area. The use of this "half inch line" does, of course, make the resulting area for any single town slightly artificial, but as this study was designed for purposes of comparison between towns this was felt to be unimportant in comparison with its advantages. The "half inch line" also has the property of over-estimating the extent of a long, irregularly shaped town in comparison with that of a compact town. This means that the air pollution of the former will be under-estimated, which is as it should be, since more will be lost by dispersion. Thus, the indices of air pollution take into account, not only fuel consumption and built-up area, but also to some extent the shape of each town.

When a "pocket" of population exists away from the main part of the town, it is necessary to take into account the population density of each area; otherwise a large but lightly-populated district would have a disproportionate effect on the estimate of built-up area. This has been done by assuming that the population in each separate area consumes the same quantity of domestic fuel per head, calculating the fuel consumption per acre of built-up area for each part separately, and finding the weighted average of these values, using the population in each part as weights.

"ATTENUATION".—The formula used in calculating correlation co-efficients where death rates are compared with pollution or social indices is the usual one, except that the root mean square referring to the death rates in the denominator is given by:

$$\sqrt{\frac{1}{83}\sum_{1}^{83}(R_1-\bar{R})^2-\frac{82}{(83)^2}\sum_{1}^{83}S_1^2},$$

where R_1 refers to the death rates, $\bar{R}$ is the average of these death rates, and S_1^2 refers to the sampling variances of each of these 83 death rates.

This contrasts with the usual term:

$$\sqrt{\frac{1}{83}\sum_{1}^{83}(R_1-\bar{R})^2}.$$

PARTICULARS OF 83 COUNTY BOROUGHS SHOWING NUMBER OF MALES AGED 45–64 YEARS (AT THE 1951 CENSUS), AIR POLLUTION AND SOCIAL INDICES (IN ARBITRARY UNITS), AND DEATH RATES (PER 100,000) FROM SIX GROUPS, OF CAUSES

County Borough	No. of Males aged 45–64	Air Pollution			Social Index				Cause of Death (Rates per 100,000 Males aged 45-64)					
		Domestic	Industrial	Power Station	Social Class	Overcrowding	Population Density	Education	Bronchitis	Pneumonia	Respiratory Tuberculosis	Cancer of Lung & Bronchus	All other Respiratory Diseases	All Non-Respiratory Diseases
Barnsley	8,366	67	87	47	52	69	54	95	135	48	70	102	20	1059
Barrow-in-Furness	8,157	37	86	50	43	41	70	57	130	72	86	119	25	1168
Bath	9,093	21	29	298	16	26	20	19	75	52	50	135	35	916
Birkenhead	15,113	53	69	59	50	68	92	60	159	80	115	169	29	1222
Birmingham	117,600	43	73	137	34	56	46	80	144	60	120	170	30	1027
Blackburn	13,389	47	70	475	39	16	82	94	187	69	83	132	33	1177
Blackpool	19,736	46	37	88	18	14	44	58	112	26	72	119	22	1285
Bolton	20,055	52	88	400	38	24	53	91	187	55	61	143	37	1250
Bootle	7,258	66	74	0	74	93	135	76	201	67	154	179	26	1044
Bournemouth	16,226	18	2	0	0	19	3	29	87	26	85	130	26	1017
Bradford	34,099	47	80	524	34	53	55	62	183	65	76	142	22	1223
Brighton	17,577	28	16	0	22	38	97	46	102	33	77	167	24	1062

(*contin.*)

NOTES: Domestic Pollution—100 P_1, where P_1 = tons of smoke produced per annum by domestic fuels per acre of built-up area.
Industrial Pollution—50 (Log P_2 + 2), where P_2 = tons of smoke produced per annum by industrial fuels per acre of built-up area.
Power Station Pollution is defined in the text.
Social Class—100 (S_1 − 2·9), where S_1 = the weighted social class score defined in the text.
Overcrowding—5 (S_2 − 8), where S_2 = percentage of households living more than one person per room.
Population Density—2 (S_3 − 20), where S_3 is expressed in terms of persons per acre.
Education—4 (S_4 − 60), where S_4 = percentage of occupied males who left school before the age of 15 years.

(*contin.*)

County Borough	No. of Males aged 45–64	Air Pollution			Social Index				Cause of Death (Rates per 100,000 Males aged 45–64)					
		Domestic	Industrial	Power Station	Social Class	Overcrowding	Population Density	Education	Bronchitis	Pneumonia	Respiratory Tuberculosis	Cancer of Lung & Bronchus	All other Respiratory Diseases	All Non-Respiratory Diseases
Bristol	49,703	33	62	44	33	31	35	56	89	52	82	143	48	997
Burnley	10,444	56	88	135	41	20	100	98	185	64	92	122	26	1313
Burton-upon-Trent	5,684	29	88	360	54	22	27	66	141	63	106	106	18	1110
Bury	7,065	36	94	272	40	19	54	84	168	32	55	117	47	1323
Canterbury	2,901	17	39	73	24	14	30	54	94	10	79	118	39	970
Carlisle	7,673	44	60	1,104	35	65	39	68	102	32	97	134	26	1314
Chester	5,458	39	61	0	31	64	58	56	105	47	105	181	10	1169
Coventry	29,173	35	75	24	32	42	34	75	95	40	87	116	29	1006
Croydon	28,021	30	33	342	8	20	35	24	105	35	63	140	15	901
Darlington	9,892	41	76	351	33	60	71	66	116	42	78	97	19	1142
Derby	16,208	49	87	581	40	29	57	79	124	50	75	130	35	1069
Dewsbury	5,988	38	79	415	39	62	37	84	177	55	55	100	17	1257
Doncaster	10,082	44	86	13	34	22	43	63	123	40	72	119	30	1082
Dudley	6,799	33	78	0	44	74	40	99	254	63	92	132	25	976
Eastbourne	6,200	21	18	67	9	4	24	32	44	41	62	120	25	963
East Ham	13,618	57	29	0	45	46	80	87	117	56	78	172	19	952
Exeter	8,563	18	24	71	22	28	34	45	85	33	80	90	30	1179
Gateshead	12,107	71	62	92	51	134	111	91	218	59	153	142	26	1215
Gloucester	7,295	29	56	114	28	38	62	46	141	57	108	125	23	1159
Great Yarmouth	5,500	28	42	74	42	1	67	80	94	26	68	101	26	1031
Grimsby	10,088	49	72	268	58	36	24	84	103	57	99	159	30	1137
Halifax	11,670	51	84	305	33	48	36	72	162	40	71	136	38	1322
Hastings	6,736	21	7	125	18	13	21	42	55	45	91	121	25	1008
Huddersfield	15,970	32	85	304	30	42	25	74	123	36	44	122	23	1244
Ipswich	11,675	25	59	143	32	14	20	62	86	37	40	117	21	875
Kingston-upon-Hull	30,930	52	75	347	57	50	60	82	187	101	118	174	16	1128
Leeds	58,306	49	68	733	31	42	44	75	186	61	96	170	27	1142
Leicester	32,286	42	67	264	26	22	78	78	98	41	98	140	27	1007
Lincoln	7,899	37	74	59	30	24	62	64	101	36	96	119	14	1024
Liverpool	77,461	70	80	588	58	81	128	73	200	71	149	210	32	1215
Manchester	75,426	65	77	166	40	38	56	79	258	68	142	201	34	1215
Middlesbrough	15,234	57	108	186	59	72	112	68	186	88	119	168	40	1249
Newcastle-upon-Tyne	32,371	63	68	1,237	37	104	90	65	148	54	126	172	30	1191
Northampton	12,487	41	56	530	22	23	36	82	128	32	87	102	15	976
Norwich	13,676	28	39	146	32	23	30	64	76	37	71	116	30	903
Nottingham	32,501	59	81	147	42	39	47	85	147	64	100	163	23	1016
Oldham	14,309	64	87	159	48	42	98	106	290	66	80	117	24	1241
Oxford	11,003	22	54	76	25	29	13	42	64	35	51	166	30	926
Plymouth	22,851	22	44	95	38	51	66	18	77	53	92	112	33	1174
Portsmouth	24,663	39	43	294	30	27	78	40	111	45	88	144	19	1060
Preston	13,534	53	88	560	47	44	65	93	185	65	92	152	28	1241
Reading	12,753	22	34	143	29	37	41	52	56	48	72	141	15	906
Rochdale	10,790	43	87	40	44	30	56	87	164	33	77	122	40	1290
Rotherham	9,258	33	68	1,194	52	52	46	92	128	42	77	119	17	1047
St. Helens	12,407	46	115	540	64	89	134	103	150	55	94	157	35	1133
Salford	18,527	80	81	56	55	56	119	103	292	68	149	206	48	1279
Sheffield	59,787	47	93	577	40	42	46	93	151	59	81	160	27	1072
Smethwick	8,449	60	91	0	38	40	37	93	162	52	144	183	36	1038
Southampton	19,900	28	33	397	31	45	31	61	85	44	124	159	33	1092
Southend-on-Sea	16,763	31	14	37	6	14	36	22	84	42	68	166	23	965
Southport	10,323	32	15	151	0	12	7	28	100	36	65	144	29	1254
South Shields	11,372	81	59	156	49	91	103	72	183	64	156	181	31	1198
Stockport	16,542	44	79	342	29	20	44	80	198	38	75	174	21	1154
Stoke-on-Trent	29,246	52	102	59	52	74	57	110	183	54	131	172	89	1124
Sunderland	18,300	67	67	349	48	120	90	82	183	69	113	156	28	1187
Tynemouth	7,052	46	50	160	44	81	72	72	111	38	122	152	38	1280
Wakefield	7,243	43	73	90	34	48	25	75	166	59	59	122	20	1021
Wallasey	10,882	53	33	64	19	20	63	18	95	45	88	142	28	1212
Walsall	11,958	37	74	48	40	58	24	95	183	65	152	147	32	1064

(*contin.*)

(contin.)

County Borough	No. of Males aged 45–64	Air Pollution			Social Index				Cause of Death (Rates per 100,000 Males aged 45–64)					
		Domestic	Industrial	Power Station	Social Class	Overcrowding	Population Density	Education	Bronchitis	Pneumonia	Respiratory Tuberculosis	Cancer of Lung & Bronchus	All other Respiratory Diseases	All Non-Respiratory Diseases
Warrington	8,984	39	91	362	65	70	71	110	245	60	78	183	22	1172
West Bromwich	9,026	35	75	22	44	79	30	94	209	74	136	169	33	1061
West Ham	17,086	74	93	346	69	90	134	101	181	67	105	197	34	1077
West Hartlepool	7,730	48	77	0	55	80	118	70	159	43	91	137	39	1173
Wigan	9,764	58	84	96	55	72	46	101	236	41	85	126	50	1272
Wolverhampton	17,669	40	91	27	33	44	26	79	139	78	125	119	27	1021
Worcester	6,766	32	48	134	27	38	17	60	93	42	110	116	17	985
York	12,120	37	66	494	35	24	33	60	126	37	68	106	19	1108
Cardiff	27,199	53	43	239	33	55	88	53	126	44	116	159	28	1225
Merthyr Tydfil	7,396	65	10	8	53	39	28	62	182	50	110	129	131	1234
Newport	12,119	36	78	946	45	62	53	59	121	31	106	172	34	1134
Swansea	18,996	29	69	42	47	48	23	62	144	35	98	184	33	1175

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SICKNESS, CHANGE OF RESIDENCE, AND DEATH*

II. SICKNESS REPORTED IN HOUSEHOLD SURVEYS AND SUBSEQUENT MORTALITY

BY

DONOVAN J. THOMPSON AND ANTONIO CIOCCO

Department of Biostatics, Graduate School of Public Health, University of Pittsburgh, Pa.

In the first paper of this series (Thompson and Ciocco, 1958) we noted that those persons who reported some illness in a morbidity survey conducted on a sample of households in the Pittsburgh Arsenal District in 1951 had died by 1956 at a higher rate than persons who did not report illness in 1951. Similarly, persons reported to be affected by smog in Donora in 1948 experienced a higher mortality between 1948 and 1957 than persons who stated in 1948 that they were not affected. These findings raise at least three questions:

(1) Is the observed higher mortality of the sick group due to a higher incidence of a specific cause of death?
(2) Is this higher mortality related to certain reported sickness?
(3) Are certain sicknesses associated with certain causes of death?

In this paper we present data in part answer to these questions.

Material and Method

A detailed description of the sources of the data analysed in this paper may be found in the paper cited above. In summary, the Donora data relate to a sample of 2,712 persons 21 years of age and over who were studied in 1948 to investigate the sickness effects of the smog episode of October of that year. This group was surveyed again in 1957 to determine, among other things, the mortality in the intervening 8 years. The first survey of the Arsenal District in 1951 provided illness information on 6,305 persons 21 years of age and over. Mortality to July, 1956, among this group of persons has been determined by a variety of methods.

* This work was supported in part by a research contract with the Air Pollution Medical Program, Public Health Service, U.S. Department of Health, Education, and Welfare.

The definitions of illness at the time of the initial survey in the two areas differed. In the 1948 Donora survey all persons answering *yes* to the question, "were you affected by smog of October 28–31?" are classified under "acute illness". The "all illness" category includes the "acute illness" group plus persons who, while not affected by the smog, answered *yes* to questions concerning the prevalence of certain chronic illnesses such as asthma, heart disease, chronic bronchitis, tuberculosis, and sinusitis. The "ill" group in the Arsenal study includes all persons who responded positively to general questions regarding sickness in the month before the survey, hospitalization in the year preceding the survey, or injury or accidents for which medical care was sought during this period.

Results

(1) Sickness and Major Causes of Death.—Table I (opposite) shows the percentages of persons who died from neoplasms, vascular lesions of the central nervous system, cardiovascular diseases, and other or unspecified causes between 1948 and 1957 for the Donora sample, and 1951 and 1956 for the Arsenal sample.

In the Donora sample the mortality rates of the "ill" group are not consistently higher than those of the "not-ill" group for any cause of death.

Mortality from cardiovascular diseases is higher for the ill males than the not-ill males in all four age groups, but they are higher in the ill females than the not-ill females in only three of the four age groups.

Mortality from vascular lesions of the central nervous system is higher among the ill females than the not-ill females in the three age groups in which it occurred, but is lower among the ill males than among the not-ill males in the two age groups in which it occurred.

TABLE I

RELATIONSHIP OF ILLNESS EXPERIENCE REPORTED TO MORTALITY RATE PER 100, BY CAUSE, SEX, AND AGE

Place	Period of Mortality	Year of Illness Experience	Sex	Age (yrs)	Illness Status	Number of Persons	Cause of Death			
							Neoplasms (140–205)*	Central Nervous System Vascular Lesions (330–334)*	Cardiovascular Lesions (410–456)*	Other
Donora	1948–57	1948	Male	21–34	Ill	187	—	—	1·07	1·60
					Not Ill	238	—	—	—	0·84
				35–49	Ill	243	1·65	—	2·47	1·23
					Not Ill	166	0·60	—	0·60	1·81
				50–64	Ill	266	3·38	1·88	7·89	7·14
					Not Ill	136	3·68	2·94	7·35	1·47
				65 and Over	Ill	100	7·00	7·00	30·00	7·00
					Not Ill	44	6·82	15·91	15·91	6·82
			Female	21–34	Ill	240	—	—	0·83	0·42
					Not Ill	252	0·40	—	0·40	—
				35–49	Ill	232	1·72	0·86	2·59	1·29
					Not Ill	162	1·85	—	—	0·62
				50–64	Ill	193	4·15	1·55	8·29	3·63
					Not Ill	128	0·78	0·78	5·47	3·91
				65 and Over	Ill	82	6·10	4·88	24·39	9·76
					Not Ill	43	4·65	4·65	27·91	4·65
Arsenal District	1951–56	1951	Male	21–34	Ill	96	—	—	1·04	1·04
					Not Ill	846	0·24	—	—	1·06
				35–49	Ill	133	0·75	—	2·26	1·50
					Not Ill	862	0·35	0·12	1·04	0·46
				50–64	Ill	133	4·51	0·75	10·53	5·26
					Not Ill	597	2·17	0·83	4·85	1·50
				65 and Over	Ill	100	7·00	7·00	15·00	10·00
					Not Ill	247	1·21	3·64	14·17	4·05
			Female	21–34	Ill	161	0·62	—	—	1·24
					Not Ill	901	—	—	—	—
				35–49	Ill	213	1·41	0·94	1·88	1·88
					Not Ill	871	0·46	0·11	0·34	0·23
				50–64	Ill	187	0·53	1·07	3·74	2·14
					Not Ill	559	1·61	0·89	2·15	0·89
				65 and Over	Ill	138	2·17	3·62	8·70	5·07
					Not Ill	261	2·68	2·68	11·11	4·21

* Numbers in parenthesis refer to the International List of Causes of Death.

The same lack of consistency is observed in the Arsenal sample (Table I). Even where a degree of consistency is present, the differences in rates are frequently small in terms of their sampling error. Consequently, we can say only that the subsequent higher mortality of the ill persons in comparison with the not-ill persons is perhaps manifested by a higher mortality from cardiovascular diseases. However, for other causes of death, the ill groups also have a higher mortality than the not-ill at certain ages. In considering these findings, it must be remembered that the ill groups contain persons with all types of illness from acute upper respiratory infections to serious forms of heart disease. To arrive at an understanding of the meaning of the higher mortality of persons reported ill, and the possible higher mortality from cardiovascular diseases, it is obviously necessary to examine in more detail the kinds of sicknesses reported by the ill group. This examination leads to the second question mentioned above.

(2) SICKNESS CLASS AND SUBSEQUENT MORTALITY.—Because of the limitations in the size of the sample, because individuals may have simultaneously several types of sickness, and because some account must be taken of variations in change of residence (as discussed in the paper cited), it is not feasible to make age-sex comparisons of mortality by illness classes. For this reason the following approach has been employed here. For the males and females of the total sample, separated into 5-year age groups, the percentages have been calculated of those who (*a*) died, (*b*) changed their residence and remained alive, and (*c*) retained their residence and remained alive during the intervals under study. These percentages are here regarded as the expectation that

an individual of a specified sex-age class will be dead, will have moved and survived, or will have remained alive at the place of residence of the first survey. By summing up this expectation for the individuals in the group with a specified illness, we obtain the number of persons expected in each of these categories, *i.e.* expected on the basis of the experience of the total sample.

In Table II we compare for the several illness classes the observed and expected number of persons who moved and persons who died. With respect to change of residence, the data in Table II show that for both the Donora and the Arsenal samples there is little difference between the observed and expected numbers in any of the sickness status classes. The reported sickness at the time of the first survey, does not, therefore, seem to be related to any subsequent change of residence.

With respect to subsequent mortality, a rather interesting relationship is noted. In both the Donora and Arsenal samples the observed mortality is greater than or equal to the expected in every illness classification except "smog only" in both sexes in the Donora sample and the "remainder" category in females in the Arsenal sample. Most of the differences are small and only in the heart disease category are the differences between observed and expected numbers large enough to result in rejecting the hypothesis of equality at the 5 per cent. significance level.

TABLE II

RELATIONSHIP OF SICKNESS CLASS TO SUBSEQUENT MOVEMENT AND DEATH, BY SEX, OBSERVED AND EXPECTED

Place	Time of Movement and Death	Year of Illness Experience	Illness Reported	Males				Females			
				Number Moved		Number Died		Number Moved		Number Died	
				Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected
Donora	1948–57	1948	Not Ill	107	110	48	57	103	107	38	49
			Acute Illness	105	105	102	96	104	101	75	68
			Smog Only	74	79	58	67	71	75	45	47
			Heart Disease	4	6	20	11	7	8	20	11
			Asthma	5	5	17	11	6	4	5	5
			Pneumonia and Bronchitis	33	26	36	28	26	22	22	17
Arsenal District	1951–56	1951	Not Ill	959	958	141	168	978	996	95	107
			Chronic Respiratory (241, 783)*	3	2	3	2	5	4	4	1
			Diabetes (260)*	2	3	3	1	6	9	5	4
			Central Nervous System Vascular Lesions (330–334)*	3	4	5	3	5	4	3	1
			Heart Disease (410–456, 782)*	9	12	21	8	20	25	17	10
			Rheumatism (720–727, 787)*	9	11	7	7	25	20	7	6
			Ill-Defined (790–795)*	10	10	6	2	22	19	5	2
			Remainder	115	109	30	25	176	160	16	22

* Numbers in parenthesis refer to the International List of Causes of Death.

RELATIONSHIP OF REPORTED ILLNESS TO S

Place	Period of Mortality	Year of Illness Experience	Illness Reported		Males				
					No.	Neoplasm (140–205)*		Cardiovascular (410–456)*	
						Observed	Expected	Observed	Exp
Donora	1948–57	1948	Not Ill		584	9	9·8	18	25
			Ill	Acute Illness	796	20	19·2	59	51
				Smog Only	509	12	11·7	25	30
				Heart Disease	46	1	1·7	12	4
				Asthma	46	2	1·8	12	5
				Pneumonia and Bronchitis	177	6	4·4	16	12
Arsenal District	1951–56	1951	Not Ill		2,552	21	27·9	73	82
			Ill	Heart Disease	47	2	1·1	12	4
				Rheumatism	42	2	1·0	2	3
				Other	373	10	5·0	19	16
			Total		3,014	35	35·0	106	106

* Numbers in parenthesis

These findings would seem to indicate that the previously reported difference in subsequent mortality between the persons who were affected by the 1948 smog episode and those who were not affected is due, in large measure, to the inclusion in the affected group of a higher proportion of persons reported to have one or more of the specific diseases about which a direct query was made in 1948. In general, while the data suggest that the mortality has been higher in groups reporting illness at the time of the first survey, only for those reporting heart disease is there a marked difference. In view of these findings it is of interest to find an answer to the third question: to determine the extent to which the relationship between a complaint of heart disease and death from heart disease is manifest as would be anticipated.

(3) SPECIFIC SICKNESS AND CAUSE OF DEATH.—In calculating the expected mortality from specific causes of death, we have applied to persons in each age group who have reported a stated illness the appropriate cause-mortality rate of the total sample. Since the numbers become small, we have grouped the causes of death into only three categories: neoplasm, heart disease, and "other". In the Arsenal sample we have grouped the sickness classes into: heart disease, rheumatism, and "other".

The observed and expected deaths from specific causes among persons in the specified sickness classes are shown in Table III. The data show that the higher mortality from heart disease among the ill group noted in Table I is due, in the main, to a higher mortality among persons who complained of heart disease at the time of the first survey. In the Donora sample, persons with asthma or pneumonia and bronchitis also experienced a higher mortality from heart disease, and the last-named group also from "other" causes of death. In the Arsenal sample, persons with "other" sickness also experienced a higher mortality from heart disease and from "other" causes of death, and the males alone from neoplasm. The sample is not sufficiently large to explore this last observation further.

SUMMARY

This is a report on the mortality experience of (*a*) a sample of 2,712 persons aged 21 years and over, resident in Donora, Pennsylvania, who were surveyed in 1948 to determine illness status with respect to the smog episode of that year and were re-surveyed in 1957; (*b*) a sample of 6,305 persons aged 21 years and over, resident in the Arsenal Health District, who were surveyed in 1951 to determine the presence or absence of sickness and for whom information on mortality up to 1956 was obtained.

In a previous paper it was reported that, in both samples, persons who claimed they were ill in the original survey died at a higher rate during the 8 and 5 year interval respectively before the second survey than persons who claimed no illness. Further analysis of the relationship of the type of illness to cause of death is reported in this paper. The major findings of this analysis are:

(1) The ill groups had higher mortality from heart disease in most age-sex subdivisions.

(2) Persons who complained of heart disease had a higher mortality than others.

E OF DEATH, BY SEX, OBSERVED AND EXPECTED

				Females					
	Other		No.	Neoplasm (140–205)*		Cardiovascular (410–456)*		Other	
	Observed	Expected		Observed	Expected	Observed	Expected	Observed	Expected
25	21	22·2	585	7	9·4	20	24·2	11	14·9
51	43	41·8	747	17	14·6	44	39·8	28	24·2
30	21	25·2	468	12	8·9	22	24·1	11	14·7
4	7	3·8	72	1	1·8	13	5·4	6	3·2
5	3	4·1	29	0	·8	4	2·4	1	1·4
12	12	9·7	146	3	3·1	13	8·7	11	5·2
82	47	58·6	2,592	20	20·5	44	46·7	31	40·6
4	7	2·6	86	0	1·4	11	4·3	6	3·3
3	3	2·4	67	2	1·0	3	3·1	2	2·4
16	18	11·3	546	6	5·1	9	12·9	18	10·8
106	75	74·9	3,291	28	28·0	67	67·1	57	57·1

ational List of Causes of Death.

(3) Persons who complained of heart disease died more often from heart disease, and those who complained of certain other conditions died more often from other causes of death.

These findings point to the value of information obtained from household surveys as a means of recognizing persons with a relatively higher risk of mortality. At least for the complaints classified as heart disease, the higher risk of dying and of dying from heart disease is apparent in the two samples. For other complaints and their possible relationship with other causes of death, more observations are required. Further analysis of the available information on these samples is also required to learn about the duration of the higher risk of mortality for the persons ill. These findings lead also to the general consideration that, if the survey of the type undertaken in Donora and the Arsenal does in fact indicate persons with higher risk of mortality from specific causes, such surveys can be used as a means for exploring more effectively the antecedent factors of the causes of death.

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FORECAST AND FOLLOW-UP

AN INVESTIGATION INTO THE CLINICAL, SOCIAL, AND MENTAL FACTORS DETERMINING THE RESULTS OF HOSPITAL TREATMENT

BY

A. QUERIDO*

Department of Social Medicine, University of Amsterdam

The Problem

The investigation reported here is based on three previous publications (Querido, 1954; Weijel and Willemse, 1955; De Levita, 1958).

In the first of these it was determined how far somatic illness was accompanied by mental and/or social stress in a random sample of patients of a general hospital. Such stresses were present in a little over 50 per cent. of a sample of 200. An attempt to systematize various forms of stress resulted in the following classification: somatic, psychosomatic, psycho-somatic-social, and parallel problems.

In the second investigation an attempt was made to determine how the needs of a sample of hospital patients could be met if problems other than those arising from the somatic illness were found to be present. In this second sample (315 cases) it was found that 44 per cent. were suffering from tensions and stresses apart from the somatic complaint which had necessitated hospital admission. It was estimated that 12 per cent. needed psychiatric consultation in order to establish diagnosis and decide upon a programme of treatment, 15 per cent. needed psychiatric treatment after discharge, 27 per cent. needed supporting treatment by the family doctor, 41 per cent. needed after-care or case-work by a social worker, and 5 per cent. needed the care of a priest.

These results indicate that many patients admitted to a general hospital may be burdened by stresses which may or may not be interwoven with the somatic illness but may well impede the chances of complete recovery and so diminish the effect of the labours of the hospital staff.

The question therefore arises whether the chances of recovery are better for patients unburdened by stresses than for patients who are bearing stresses they are unable to handle.

The answer might be found by carrying out a follow-up survey; if during the hospital stay it should be noted that some patients suffer from stress and others do not, an investigation of their condition some time after discharge might show a difference in the recovery frequency of the two groups.

De Levita (1958) ran such an investigation as a pilot study; he limited his sample of 376 patients to surgical cases and had only one contact with the patient, *i.e.* the follow-up visit, in which he both ascertained the degree of recovery and the presence or absence of stresses.

His conclusion was that 38 per cent. of his sample was not burdened by stress and that a significantly larger number of these patients had recovered, in comparison with the burdened group.

On the basis of these preliminary investigations it was decided to place the problem in a wider frame of reference and at the same time to attempt a numerical measurement. It was hoped that a method might be devised which might be used by the clinician in considering prognosis and therapy and might help him to forecast the result of the clinical endeavour more accurately.

The following questions were formulated:

(1) Is it possible on the basis of a routine method to assess the presence of mental and (or) social stresses in a patient admitted for a somatic illness to a general hospital?

(2) If so: is there a relation between this assessment and the condition of the patient as ascertained in a follow-up investigation?

(3) Are the assessments under (1) and (2) related to the purely clinical assessment, *i.e.* diagnosis and prognosis?

* In collaboration with Mrs. M. T. F. Alkemade-v. Kalmthout, M.D., P. Bos, M.A. (social psychologist), Mrs. J. H. du Pon-Nienhuis, M.D., Mrs. W. J. Z. Gorter-Willemse, B.A. (social worker), F. J. Hogendoorn, B.A. (statistician), V. M. Oppers, M.D., J. A. Verdoorn, M.D., and J. A. Weijel, M.D.

(4) If relations under (2) and/or (3) are found to exist, is it possible to distinguish in the assessment under (1) factors which might play a specific role in these relations?

Methods

(1) Method of Integrative Assessment.—The technique of the biographical case-history—in contrast to the ordinary case-history of clinical routine—will be familiar. Extensive talks with the patient, with relatives, and with persons from narrower and wider circles of contacts are necessary, supplemented by social and socio-medical data. Usually the number of working hours required for a biographical case-history is not less than 7, and normally it takes more than double this time. For scientific purposes this method may be indispensable, but it cannot be used as a routine procedure in the wards of a general hospital.

A method was therefore devised to enable a rapid assessment of the nature and intensity of the mental and social problems of the patient to be integrated with the clinical data. Furthermore this information was recorded in such a way that quantitative processing was possible.

To fulfil these conditions the so-called psycho-social case-history form described by Weijel (1958) was used. This form comprises a compact survey of the patient's life-history in which important and traumatic occurrences can be found without trouble, and allows the investigator if possible to gain an impression of the patient's life-attitude, ambitions, and aspirations, and the way in which these have been or are being fulfilled (see Appendix).

The completion and assessment of the psycho-social case-history was the task of a team of three (a general physician, a social worker, and a psychiatrist) working parallel to but independent from the ordinary hospital staff for the purpose of this investigation.

The general physician was a young man who filled the role of ward-doctor or family physician. It was his duty to establish and to maintain the contact with the patient and to interpret to those in the hospital who decide the fate of the patient, his human as well as his medical history. The psycho-social case-history was started within 48 hours of admission, and at the same time the general physician took note of the clinical findings. Next the case was discussed by the team. In some instances it was possible at this early stage to reach an opinion concerning the presence of stress and its nature; in others either the social worker or the psychiatrist felt the need of more extensive data. These might be provided by the general physician or the psychiatrist or social worker might make his own investigation. After the required data had been gathered the team met again and this time attempted to reach a definite conclusion. Previous history and the patient's behaviour in former difficulties, his attitude towards actual problems, and his subjective expressions were taken into account.

A decision did not rest upon the question whether stress was adjudged to be present but upon the question whether the patient was hampered by his problems. When it was decided that the patient was not able to handle his problems and was hampered or burdened by them, the team used the expression *distress*. When problems were mentioned by the patient but the team judged that he was able to manage them, the expression *stress* was used. In this article, therefore, "distress" refers to social and/or psychic tensions too heavy for the patient to bear, while "stress" refers to tensions which are satisfactorily integrated in the patient's life-pattern. The term "somatic" means that no distress could be found or that the somatic illness was so serious that it dominated the entire picture. The type of "distress" was classified as follows: psychic only; psychosomatic; somatic with psychic parallel problems; somatic with social parallel problems; somatic with psychic and social problems.

Furthermore, the work of the team was observed by a psychologist, who followed its groupdynamic action and studied the way in which its judgment came into being. In this way it was possible to prevent the judgment of the team being distorted by the domination of any one member.

If it be agreed that the team's assessment may be considered as an integrated evaluation of the patients' problems the questions to be answered may be stated simply as follows:

(1) What is the value of integrated and clinical assessments in relation to the patients' condition in the follow-up?

(2) Does the integrated assessment contain specific elements, and if so, are these elements different from those which comprise the clinical prognosis?

(2) Method of Follow-up Assessment.—An attempt was made to visit the patient in his home 6 months after discharge. It was not always possible to keep exactly to this period, which in some cases extended to 18 months, the average being 7 months after discharge.

The follow-up investigation was carried out by a physician who knew the contents of the clinical case-history, but was unaware of the psycho-social data

and the team's assessment. In reaching a conclusion on the condition of the patient, objective data (behaviour, resuming of work) as well as subjective observations were taken into account. It was not intended that factors of stress should be examined again, and, although it was sometimes unavoidable to touch on these subjects during the visits, these findings were never used to change the original assessment of the team. The doctor undertaking the follow-up was unaware of the conclusions of the team and the team was not told about his conclusions to avoid bias in the later stages of their work.

There was some difficulty in formulating the follow-up assessment. The term "cured" could not be used, because it required a distinction to be made between anatomical, physiological, and functional cure, and between objective and subjective cure. For some time the term "benefit" was used, but this was finally rejected because it seemed to imply a too direct causal relationship between hospital admission and the later condition of the patient. Finally the neutral terms "satisfactory" and "unsatisfactory" were chosen, and these are used in the rest of this paper. Cases were assessed as "satisfactory" when the patient was:

(*a*) free from any complaint;

(*b*) suffering from typical residual complaints (pain in scar, etc.) only;

(*c*) free from any complaint for a time but now showing sharply-defined symptoms which could not possibly be related to the illness for which he had been admitted to hospital.

The term "unsatisfactory" was used for all other cases, in which the patient was: (*a*) free from complaints for some time but now experiencing a return of the former symptoms; (*b*) suffering from complaints equal to or worse than those experienced before admission; (*c*) slightly improved but substantially unchanged; (*d*) suffering from a recurrence, with or without a complaint-free period.

(*3*) *Clinical Assessment.*—The general physician made a prognosis in consultation with the department physician in the light of the clinical case-history. An attempt was made to estimate the patient's chances of recovery as accurately as possible (recovery in the sense of a return of well-being and a disappearance of the symptoms which had led to admission) having regard to the medical, technical, and somatic side of the problem. This assessment was meant to show how far the illness was reversible. The prognosis was recorded as "favourable" or "unfavourable".

The various assessments to be compared may thus be designated as follows:

Assessment	*Good*	*Bad*
(1) Integrated	No stress or Stress	Distress
(2) Clinical	Favourable	Unfavourable
(3) Follow-up	Satisfactory	Unsatisfactory
(4) Integrated Clinical	Right Confirmed	Wrong Not confirmed

Digest of Data

From each patient the data from the social-psychological case-history, clinical case-history, team assessment, follow-up, and prognostic assessment were coded and transferred to punch-cards. For each patient investigated the following facts were known: age; sex; civil status; religion; diagnosis on admission and discharge; duration of complaints before admission; duration of hospital stay; number of former admissions; results of laboratory examinations; death, divorce, and remarriage of parents; evaluation of parents as educators; composition of family of origin and number among siblings; schooling and profession; hobbies; situation in own family; financial condition; dwelling situation; employment.

Classification of Patients

A psycho-social case-history was taken of about ± 2,200 patients, admitted to the Weesperplein Ziekenhuis in Amsterdam*. No selection of patients was made. All patients were investigated who were admitted as from February 1, 1955, with the following exceptions:

(*a*) Patients younger than 15 and older than 65;

(*b*) Patients who on admission were in poor condition, great pain, or obviously dying;

(*c*) Patients who could be expected to remain only a very short time, for instance for tonsillectomy;

(*d*) When admissions were very frequent every other patient was excluded.

* The Weesperplein Ziekenhuis is a municipal hospital of 320 beds with departments of internal medicine, surgery, ear-nose-and-throat diseases, gynaecology, rheumatism, and paediatrics. Practically all patients admitted are insured with the sick funds under the sick funds legal arrangements. They pay 2·6 per cent. of their income and receive without extra cost all kinds of medical care, including hospital treatment. Recommendations for admission may originate from the family doctor, consultant, or hospital out-patient department. Before admission, patients thus insured are screened by a controlling medical board with which the decision rests.

Follow-up visiting started in December, 1955, and towards the end of 1957 follow-up visits had been concluded in 1,650 cases, and it was decided to stop the investigation. Omitting patients who could not be found, 1,630 were left, and these make up the sample studied in this paper.

In evaluating the material, it was assumed that the factors investigated were independent of each other, but when the difference between the actual results and the results expected on the basis of this assumption was larger than could be explained by chance, the assumption was rejected in favour of the hypothesis that the factors were related.

Since the sample was judged to be very heterogeneous and a great number of factors might influence the result, *P* was fixed at a very low value, *i.e.* 0·1 per cent.

If in this way a relation was found to exist, its direction was determined on social and medical grounds on the basis of the figures; it was not attempted to calculate this direction.

Table I reviews various demographical data of the patients as compared with the population of Amsterdam.

This Table shows that the percentage of unmarried among the patients is half that among the general population. The percentage of married is the same in both groups. The percentage of persons widowed or divorced is three times as high in the patient-group as in the general population. The difference between the relative number of unmarried is partly explained by the difference in composition of the younger age groups. The percentage of older people in the patient groups increases with age, so that the oldest patient group is twice as large as the same age group in the population. But, even if we assume that all widowed and divorced belong to this oldest age group, this cannot explain the concentration of those whose marriage had terminated among the hospital patients.

While the number of women in the general population exceeds the number of men, the relative difference is much larger in the hospital population. The presence of the department of gynaecology is not sufficient to explain this difference. In all Amsterdam hospitals we find an excess of female patients of 14 per cent., but the excess in the Weesperplein Ziekenhuis is even larger.

The denominational grouping is compared with the data given in by the last official census, but this comparison may be of little value since the way in which religious affiliations was inquired into may have been totally different.

TABLE I
DEMOGRAPHIC DATA

Civil Status	Unmarried		Married		Widowed and Divorced		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Patients	267	16·4	1,055	64·7	308	18·9	1,630	100
Population (15–64 yrs)	172,542	31·1	348,541	62·7	34,655	6·2	555,738	100

Sex	Male		Female		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Patients	630	38·7	1,000	61·3	1,630	100
Population (15–64 yrs)	267,717	48·2	288,021	51·8	555,738	100

Age Group (yrs)	15–19		20–29		30–39		40–49		50–59		60–65		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Patients	105	6·4	244	15·0	311	19·1	374	22·9	396	24·3	200	12·3	1,630	100
Population (15–64 yrs)	58,913	10·6	134,000	24·1	123,914	22·3	112,520	20·3	92,923	16·7	33,468	6·0	555,738	100

Religion	None		Protestant		Catholic		Jewish		Others		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Patients	593	36·4	656	40·2	337	20·7	29	1·8	15	0·9	1,630	100
Population (entire)	363,355	45·2	218,184	27·2	187,458	23·3	5,269	0·7	29,328	3·6	803,594	100

Geographical Distribution	Old East	City	New West	North	Old West	Old South	New South	New East
Ratio of Patients to Population	1:286	1:359	1:389	1:407	1:425	1:434	1:530	1:540

The geographical distribution shows that most of the patients lived in the districts which were closest to the hospital.

Thus Table I indicates that the hospital population differs appreciably from the general population of Amsterdam. It is not impossible that the population of the Weesperplein Ziekenhuis differs from that of other hospitals. These are most interesting questions which must, however, be left at present.

Results

Team Assessment compared with Follow-up Assessment

In 871 of the 1,630 cases the team reached the conclusion that no particular distress was present; in 759 cases distress was found. This result is shown by age group in Table II, and by sex in Table III. The Tables show no relationship between the occurrence of distress and the age or sex of the patients.

Table II
TEAM ASSESSMENT BY AGE GROUP

Age Group (yrs)	Under 29		30–49		50 & Over		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
No Distress	181	51·9	353	51·5	337	56·5	871	53·4
Distress	168	48·1	332	48·5	259	43·5	759	46·6
Total	349	100	685	100	596	100	1,630	100

$0{\cdot}1 < P < 0{\cdot}2$

Table III
TEAM ASSESSMENT BY SEX

Sex	Men		Women		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
No Distress	342	54·3	529	52·9	871	53·4
Distress	288	45·7	471	47·1	759	46·6
Total	630	100	1,000	100	1,630	100

$0{\cdot}5 < P < 0{\cdot}7$

The follow-up showed that 817 patients were in a satisfactory condition and 813 in an unsatisfactory condition. Table IV shows that more persons under the age of 50 were in a satisfactory condition than would be expected by chance, Table V shows that the follow-up was not related to sex, and Table VI shows a positive relationship between absence of distress and a satisfactory follow-up.

Tables II, III, IV, V, and VI suggest that the follow-up assessment is related to the team assessment but that the team assessment is not related to age. Therefore the relation that exists between follow-up assessment and age (Table IV) does not underly the relation found between follow-up assessment and team assessment. It has also been shown that sex is proved unrelated either to follow-up assessment or to team assessment.

Table IV
FOLLOW-UP ASSESSMENT, BY AGE GROUP

Age Group (yrs)	Under 29		30–49		50 & Over		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	205	58·7	353	51·5	259	43·5	817	50·1
Condition Unsatisfactory	144	41·3	332	48·5	337	56·5	813	49·9
Total	349	100	685	100	596	100	1,630	100

$P < 0{\cdot}001$

Table V
FOLLOW-UP ASSESSMENT BY SEX

Sex	Male		Female		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	341	54·1	476	47·6	817	50·1
Condition Unsatisfactory	289	45·9	524	52·4	813	49·9
Total	630	100	1,000	100	1,630	100

$P < 0{\cdot}01$

Table VI
FOLLOW-UP ASSESSMENT RELATED TO TEAM ASSESSMENT

Team Assessment	No Distress		Distress		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	592	68·0	225	29·6	817	50·1
Condition Unsatisfactory	279	32·0	534	70·4	813	49·9
Total	871	100	759	100	1,630	100

$P < 0{\cdot}001$

The various types of distress were distributed in the sample as shown in Table VII.

Table VII
TYPE OF DISTRESS

Distress	Psychic	61	759*
	Psychosomatic	132	
	Somatic/Psychic	354	
	Somatic/Social	67	
	Somatic/Psychic/Social	145	
Somatic (= No distress)			871
Total			1,630

Table VIII (overleaf) shows that these various types bore a steady relationship to condition at follow-up, so that no particular type of distress influenced the results of the follow-up investigation in any specific way, although the presence of any type of distress was closely associated with an unsatisfactory follow-up.

TABLE VIII

FOLLOW-UP ASSESSMENT RELATED TO TYPE OF DISTRESS

Distress	Psychic		Psychosomatic		Som./Psych.		Som./Soc.		Som./Psych./Soc.		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	19	31·1	37	28·0	106	29·9	19	28·4	44	30·3	225	29·6
Condition Unsatisfactory	42	68·9	95	72·0	248	70·1	48	71·6	101	69·7	534	70·4
Total	61	100	132	100	354	100	67	100	145	100	759	100

CLINICAL DIAGNOSIS AND PROGNOSIS COMPARED WITH FOLLOW-UP ASSESSMENT

The diagnoses recorded on discharge from hospital were classified in sixteen groups (Table IX). In this way a reasonable number of groups of sufficient size could be obtained, most of which were sufficiently homogeneous. However, six groups were still too small for statistical work (1, 2, 6, 11, 14, 15). These are shown in the left-hand corner of Fig. 3; together they contain 178 of the 1,630 cases.

Table X (1) shows that a relationship exists between the remaining ten diagnostic groups and the condition at follow-up. It appears, however, that for two groups (*viz.* 3. Circulatory System, and 12. Rheumatism) the unsatisfactory follow-up is exceptionally high, and if these two groups are omitted, the total findings (Table X (2)) are appreciably altered.

It may therefore be concluded that in the large majority of cases no relation exists between clinical diagnosis and condition at follow-up; apart from these two exceptions (3 and 12), no single diagnosis

TABLE IX

DIAGNOSTIC GROUPS

Diagnosis	Number of Cases
1. Malignancies	18*
2. Respiratory Tract (mainly chronic, bronchitis, asthma)	47*
3. Circulatory Tract (mainly arteriosclerosis and hypertension)	106†
4. Sex Organs (sterility, benign tumours, prolaps, hypertrophia of prostate)	243
5. Urinary Tract (Kidney disease, cystitis)	52
6. Digestive Tract (except 7, 9, and 10) (mainly chronic enteritis, chronic colitis, diseases of liver and pancreas)	48*
7. Appendicitis (acute and chronic)	306
8. Herniae	136
9. Diseases of the Gall-bladder	189
10. Ulcus ventriculi and duodeni	102
11. Disturbances of the internal secretory system (diseases of thyroid and diabetes)	25*
12. Rheumatism (mainly chronic)	53†
13. Accidents	101
14. Psychiatric Diseases	5*
15. Observation (no definite diagnosis on discharge)	35*
16. "Other diagnosis" (diseases of blood, acute infections of respiratory tract, diseases of bones and muscles)	164
Total	1,630

* Groups totalling less than fifty patients were regarded as too small for valid statistical work. Omitted from Table X (1).
† Too heterogeneous. Omitted from Table X (2).

TABLE X

FOLLOW-UP ASSESSMENT RELATED TO DIAGNOSTIC GROUPS

(1) Omitting 1, 2, 6, 11, 14, 15

Diagnostic Group	3		4		5		7		8		9	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	37	35	114	47	26	50	181	59	84	62	98	52
Condition Unsatisfactory	69	65	129	53	26	50	125	41	52	38	91	48
Total	106	100	243	100	52	100	306	100	136	100	189	100

(2) Omitting above plus 3 and 12

Diagnostic Group	10		12		13		16		(1) Total		(2) Total omitting Groups 3 and 12	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	48	47	15	28	60	60	95	58	758	52·2	706	54·6
Condition Unsatisfactory	54	53	38	72	41	40	69	42	694	47·8	587	45·4
Total	102	100	53	100	101	100	164	100	1,452	100	1,293	100

$P < 0{\cdot}001$ $0{\cdot}02 < P < 0{\cdot}05$

produces follow-up conditions which are significantly more or less satisfactory.

On the other hand there is a clear relation between prognosis and diagnosis, and one diagnostic group may produce more instances of favourable prognosis than another.

Table XI shows that a satisfactory follow-up condition is significantly related to a favourable prognosis.

TABLE XI
FOLLOW-UP ASSESSMENT RELATED TO CLINICAL PROGNOSIS

Clinical Prognosis	Favourable		Unfavourable		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	660	58·5	157	31·1	817	50·1
Condition Unsatisfactory	468	41·5	345	68·9	813	49·9
Total	1,128	100	502	100	1,630	100

From the foregoing the following conclusions may be drawn:

(*a*) that diagnosis and condition at follow-up are not related (with two exceptions);
(*b*) that diagnosis and prognosis are related;
(*c*) that prognosis and condition at follow-up are related.

This leads to the conclusion that the elements which determine prognosis are distinct from those on which diagnosis is based.

This might be considered a rather cumbrous way of formulating the well-known fact that the same diagnosis may give rise to a favourable as well as an unfavourable prognosis, but this analysis was necessary in order to ascertain whether both aspects of the clinical judgment—diagnosis and prognosis—are similar, and if not which should be compared with the team assessment.

COMPARISON OF CLINICAL ASSESSMENT AND TEAM ASSESSMENT

A diagnosis might be regarded as a summary of the condition of the patient at a given moment; the integrated team assessment is also a summary of the type of distress from which the patient is suffering. Both assessments are in a sense "forecasts". When the elements on which diagnosis is based are given a dynamic character, a prognosis arises, and in the same way the designation "no stress" or "distress" is a forecast because it has an implication for the future. This investigation aims at testing both forecasts against the observations made at a follow-up examination.

Before the results of this comparison are discussed, it must be decided whether the two forecasts are identical, whether "no stress" means the same as "prognosis favourable" and "distress" means the same as "prognosis unfavourable".

"No stress" represents the judgment of the team that no tensions and conflicts are present in the patient which he is unable to manage. In this situation his chances of recovery depend solely on his bodily condition, and if on somatic grounds the clinical forecast is "favourable" the patient's prospects are good. In such cases "prognosis favourable" and "no stress" are identical, in the sense that they forecast the same result.

But if the clinical prognosis is "unfavourable", the team assessment of "no stress" is no longer identical with a favourable prognosis, and notwithstanding the fact that no serious tensions are found the chance of recovery may be small on somatic grounds. This situation was found in a number of patients and will be referred to later on.

"Distress" represents the judgment of the team that the patient is suffering from tensions and conflicts that he is unable to manage; in some cases the bodily illness is closely intertwined with these tensions, and in others the two groups of phenomena may be distinct. It is, however, judged improbable that the patient will recover as long as the tensions are present, or that he will reach a satisfactory condition even if a somatic recovery is achieved while the distress remains. Therefore, irrespective of the clinical prognosis of the somatic illness, the presence of "distress" implies that the chance of finding a satisfactory condition on follow-up is smaller than in cases of "no stress".

"No stress" thus signifies a favourable prognosis where this is not precluded by the somatic condition, but "distress" always signifies an unfavourable prognosis.

We have seen that the clinical diagnosis and the condition at follow-up are independent of each other. The same is true for the team assessment (*i.e.* the type of distress). The specific judgment of clinic and team are not represented in the follow-up assessment, but the clinical prognosis and follow-up assessment are correlated, and the same is true of the team assessment and the follow-up assessment.

Clinical Assessment and Team Assessment in General.—Table VII shows that 871 patients were judged by the team to be free of distress; of these 592 were found to be satisfactory at follow-up, and 279 unsatisfactory. Table XI shows that the clinical prognosis was favourable in 1,128 cases; of these

660 were found to be satisfactory at follow-up, and 468 unsatisfactory.

According to Table VI, 759 patients were judged by the team to be distressed; of these 225 were found to be satisfactory at follow-up, and 534 unsatisfactory.

Of the 502 patients for whom the clinical prognosis was unfavourable (Table XI), 345 were shown to be unsatisfactory at follow-up and 157 satisfactory.

Table VI and Table XI both suggest that there is a relationship between clinical forecast and team forecast on the one hand and the result of the follow-up investigation on the other hand, within our limit of probability of 0·1 per cent.

It will be clear, however, that there is a considerable discrepancy between Table VI and Table XI; the two forecasts do not seem to show the same degree of approximation to the actual follow-up findings; the accuracy of the two forecasts may be compared by combining Tables VI and XI as in Table XIIA.

This Table shows that a roughly equal number of patients were on follow-up found to be satisfactory and unsatisfactory. According to the team forecast, a satisfactory condition was expected in 53·4 per cent., and according to the clinical forecast in 69·2 per cent. The deviation of the clinical forecast from the actual state of affairs seems therefore to be considerably larger than the deviation of the team, but this reasoning is not quite sound, because the figures in Table XIIA do not show whether any individual patient for whom a forecast was made in a given sense is the same patient for whom the follow-up condition is described in the same sense. The time relationship between confirmed and not-confirmed forecasts therefore differs from the totals shown in Table XIIA. To meet this objection the cases were arranged diagramatically as in Table XIIB.

TABLE XIIA

COMPARISON OF CLINICAL PROGNOSIS AND TEAM ASSESSMENT
SUMMARY OF TABLES VI AND XI

Condition at Follow-up	Total		Clinical Prognosis				Team Assessment			
			Favourable		Unfavourable		No Distress		Distress	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Condition Satisfactory	817	50·1	660		157		592		225	
Condition Unsatisfactory	813	49·9	468		345		279		534	
Total	1,630	100	1,128	69·2	502	30·8	871	53·4	759	46·6

TABLE XIIB

COMPARISON OF CLINICAL PROGNOSIS AND TEAM ASSESSMENT
EVALUATION OF EACH SUB-GROUP

Condition at Follow-up	Satisfactory 817				Unsatisfactory 813			
Clinical Prognosis	Favourable 660 *right*		Unfavourable 157 *wrong*		Favourable 468 *wrong*		Unfavourable 345 *right*	
Team Assessment	No distress 497 *right*	Distress 163 *wrong*	No distress 95 *right*	Distress 62 *wrong*	No distress 168 *wrong*	Distress 300 *right*	No distress 111 *right*	Distress 234 *right*

TABLE XIIC

COMPARISON OF ACCURACY OF CLINICAL PROGNOSIS AND TEAM ASSESSMENT

Accuracy		Right		Wrong		Total	
		No.	Per cent.	No.	Per cent.	No.	Per cent.
Clinical Prognosis	Favourable	660		468		1,128	
	Unfavourable	345		157		502	
	Total	1,005	61·6	625	38·4	1,630	100
Team Assessment	No distress	703		168		871	
	Distress	534		225		759	
	Total	1,237	75·9	393	24·1	1,630	100

The meaning of the evaluations "right" and "wrong" will be clear. Attention is drawn, however, to the penultimate team-evaluation. This group is assessed as "no stress" and "unsatisfactory follow-up", but the assessment is evaluated as "right" because this group comprises 111 patients with somatic illness with an unfavourable prognosis as has been confirmed by the follow-up. As stated above in such cases "no stress" does not imply a better chance of recovery.

The clinical and team forecasts obtained in this way are summarized in Table XIIc, which shows that the clinical forecasts were confirmed in 61·6 per cent of cases and the team forecasts in 75·9 per cent, the difference in accuracy thus demonstrated being only slightly smaller than apparent in Table XIIa.

This difference may be explained chiefly by the fact that a favourable clinical prognosis was frequently not confirmed; on the other hand the unfavourable team forecast also exceeds the results found on follow-up though by a smaller percentage.

Clinical Assessment and Team Assessment in Particular Diagnostic Groups.—It has been shown that the clinical forecast is related to diagnosis. The same is true for the team forecast. Since for the purpose of this investigation the prognosis was based on the somatic and medical-technical considerations only, a correlation between prognosis and diagnosis indicates that both are based on the same data. A correlation between the team assessment and the diagnosis may indicate that the team based its judgment also on somatic findings, but this result may also indicate that "distress" and "no stress" were not equally distributed throughout the diagnostic groups, or that there was a tendency on the part of the team to admit the presence of distress more readily in some diagnostic groups than in others.

To this question it is extremely difficult to find an exact answer. It was necessary for the team to take note of the clinical diagnosis, and its judgment may have been influenced beyond the limits of the exact data. On the other hand the hospital staff were influenced in their turn by the work of the team, which probably had little effect on diagnosis but may have affected treatment and therefore prognosis. For the purpose of this investigation, the team and the clinical staff worked separately and no co-ordination was sought, but in the 2-year period of the work a certain inter-reaction undoubtedly developed, and the extent of this cannot be ascertained. If, however, certain diagnostic groups show a specific deviation between clinical and team assessment some inkling of the effect of this inter-reaction might be obtained.

In Fig. 1 (overleaf) the total number of patients with a satisfactory follow-up on the diagonal is indicated by diagnostic groups in absolute figures. The circles mark the number of cases in which the clinical prognosis was favourable, and the triangles the number of cases in which no stress was found. The circle or triangle is situated closer to the diagonal the greater the number of confirmed forecasts.

In Fig. 2 (overleaf), the same is shown for cases with an unsatisfactory follow-up. In both diagrams the diagnostic groups which were too small have been discarded.

In Fig. 1 the triangles are situated roughly in a straight line, the only exception being Group 10 (stomach and duodenum) which shows that the deviation of the team forecast was constant with one exception. The circles, however, show a much more irregular picture, some approaching the diagonal more closely than the corresponding triangles and others being further away. In Groups 7, 8, and 9 (appendicitis, hernia, gall-bladder) the clinical forecast approaches the real state of affairs more closely than the team forecast. In Groups 4, 13, and 16 (sex organs, accidents, "other diagnoses") the deviation of both forecasts is about equal. In Group 10 (stomach and duodenum) the clinical forecast approaches the follow-up findings much more closely than that of the team.

Fig. 2, which shows these relations for cases with an unsatisfactory follow-up, is quite different. The deviation between the clinical and team forecasts is larger in most diagnostic groups. In all except Group 3 (circulatory tract) the unfavourable clinical prognoses differ markedly from the follow-up findings. The team forecast, however, shows the same deviation as in Fig. 1 (4, 7, 8, 9) or approaches the diagonal more closely (3, 10, 16) than the clinical forecast.

When Figs 1 and 2 are combined by adding all confirmed forecasts—favourable as well as unfavourable—for each diagnostic group (Fig. 3), the wider deviation of the clinical forecast remains visible; for practical purposes the integrative forecast is within the 70 per cent. line, Group 10 being the only exception. The clinical forecast is in no instance within the 70 per cent. line and is sometimes outside even the 60 per cent. line.

The crosses in Fig. 3 indicate the percentage of confirmed favourable forecasts. The distance between the cross and the corresponding circle or triangle indicates the discrepancy between favourable and unfavourable assessment and therefore the direction in which this forecast tends to deviate. When a cross coincides with a circle or triangle, the

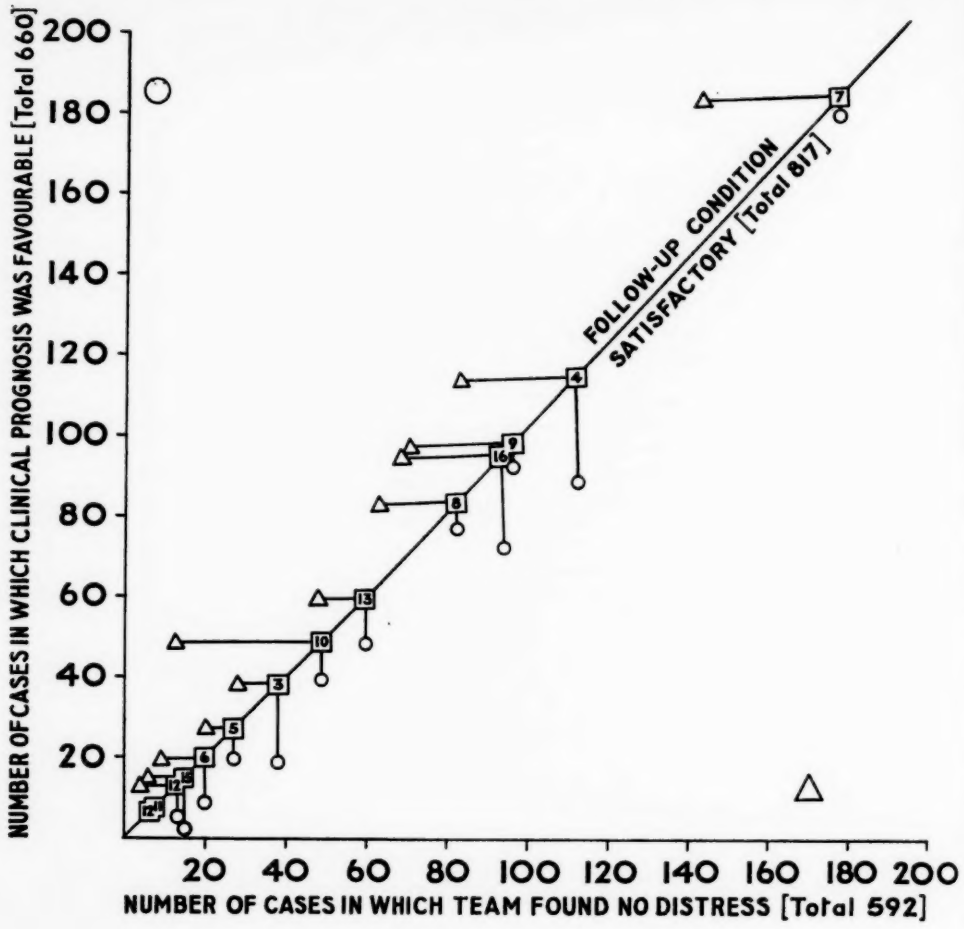

FIG. 1.—Favourable forecast of clinic and team by diagnosis as confirmed by follow-up.

deviation in the forecast is equal on both sides (an equal number of non-confirmed favourable and unfavourable forecasts). If a cross is situated between the diagonal and a circle or triangle, then the forecast deviates towards the optimistic; if the cross is outside the corresponding symbol, then the forecast has been too pessimistic.

Fig 3 (overleaf) shows clearly that the clinical forecast as a rule is too optimistic; if the integrative forecast is at fault, the error is towards the pessimistic side.

The nature of the diagnosis may offer at least a partial explanation of these findings. Groups 4, 7, 8, and 9 (appendicitis, hernia, gall-bladder, sex organs) have this in common that medical-technical considerations usually allow a favourable prognosis. If the prognosis is based on the somatic condition, it will in the large majority of such cases be favourable. But the team forecast takes other elements into account. If distress is found, then, as Fig. 2 shows, it is highly probable that the unfavourable team forecast approximates more closely to reality

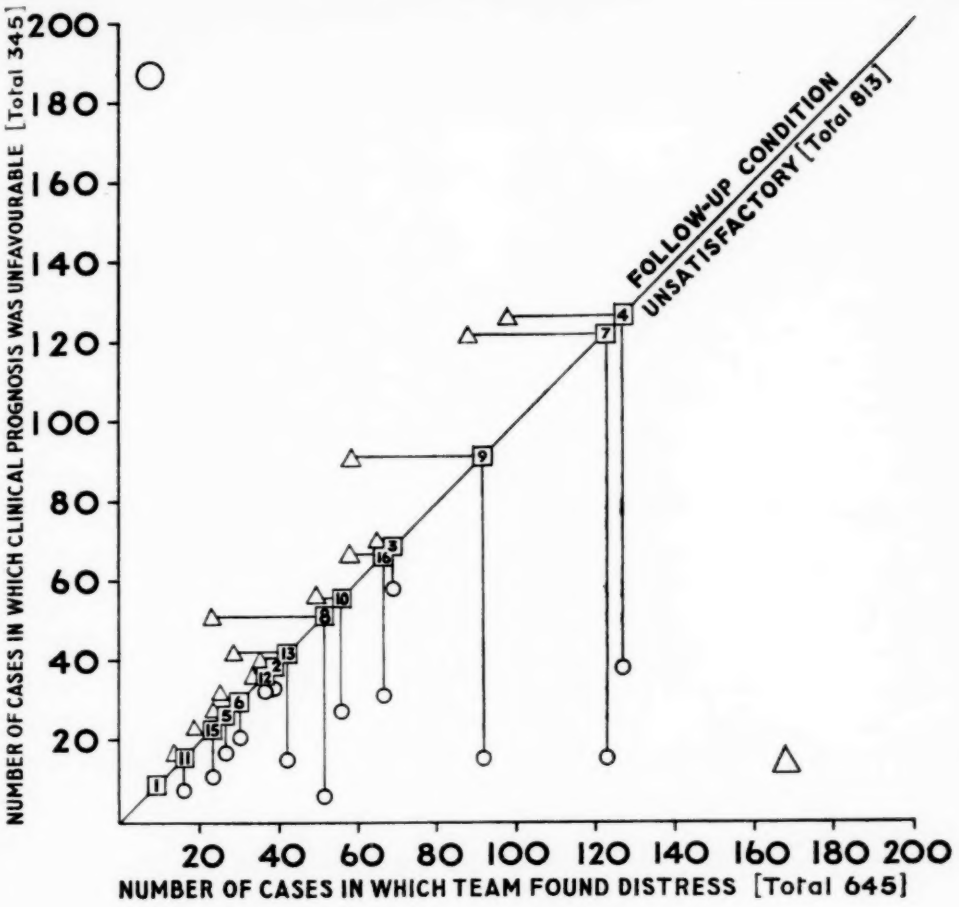

FIG. 2.—Unfavourable forecast of clinic and team by diagnosis as confirmed by follow-up.

(= follow-up finding) than the favourable forecast of the clinic, and the distress gives more weight to the forecast than does the somatic condition. An opposite state of affairs is shown in Fig. 1. Here the favourable clinical forecast is more frequently confirmed and the degree to which the team over-estimated the patients' stresses becomes apparent.

This deviation is nearly constant for all diagnostic groups except Group 10. The number of cases in Group 10 in which distress was found and in which the clinical prognosis was unfavourable, approaches very closely to reality (Fig. 2), but distress was assumed to be present in several cases with a favourable prognosis in which it was not confirmed (Fig. 1). It may be surmised that in dealing with this group the team was strongly influenced by the diagnostic implications, and it is not improbable that this resulted in a reversal of proof. The team could not accept that a patient with a stomach or duodenal ulcer should not be suffering from stress and took the presence of the ulcer as a proof of the presence of tension. According to the follow-up, a considerable

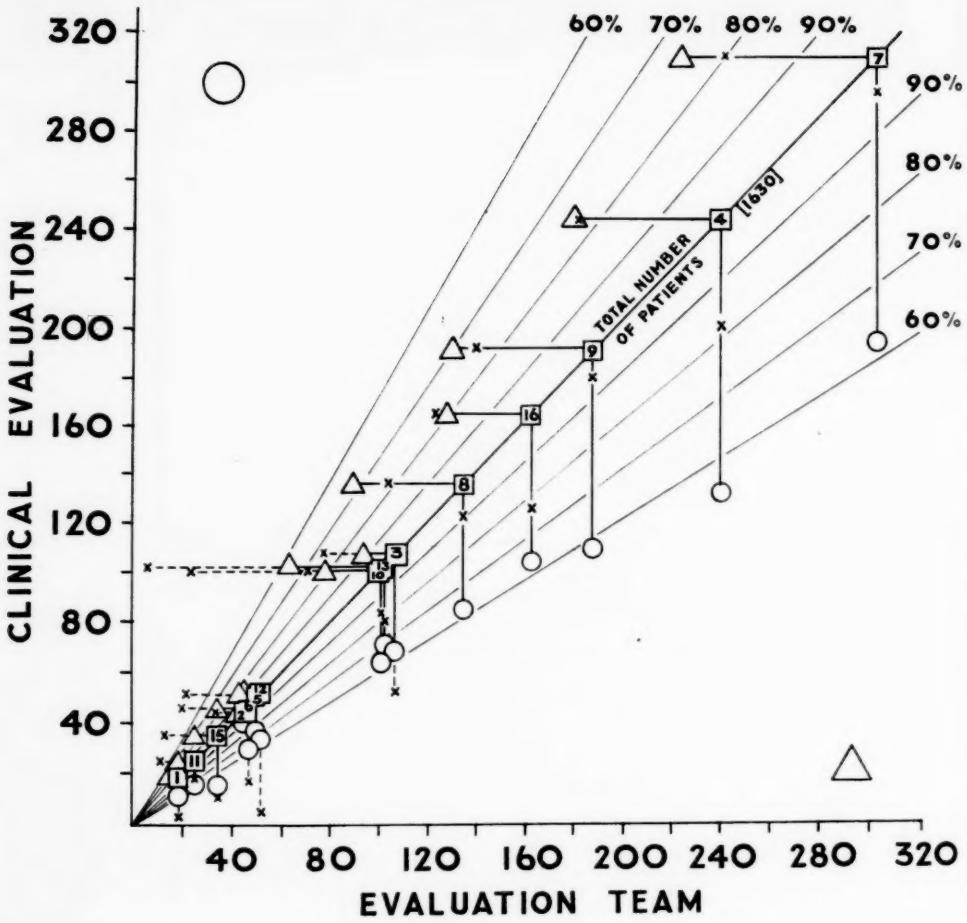

FIG. 3.—All confirmed forecasts by diagnosis.

number of these assessments were wrong, and this is the only diagnostic group in which this happened. It is justifiable to say this because this example shows that a reversal of proof if it occurs shows clearly in the results.

As has been seen the team deviates in an almost constant way towards the pessimistic side; in Groups 3 and 12 (circulatory tract; rheumatism), however, the team assessment is more optimistic than that of the clinicians. Group 1 (malignancies) seems to show the same tendency but is too small for reliable comparison.

Unlike Groups 4, 7, 8, and 9, Groups 3 and 12 consist mainly of patients with unfavourable prognoses. In such cases it is irrelevant whether distress is present or not, and in them an unfavourable clinical prognosis is most often confirmed by an unsatisfactory follow-up.

Not all patients from Groups 3 and 12 show an unsatisfactory follow-up, but the number of confirmed favourable clinical forecasts is smaller than the confirmed favourable team assessments. Thus, even in cases of serious physical illness it may be important for the patient whether he is suffering

from extra stresses or not. The same seems to be true for the malignancies (Group 1). If no distress is present, the patient has a better chance of a satisfactory outcome than might be surmised from his physical condition alone. However, these groups are too small for final conclusions to be drawn.

These results demonstrate the existence of a marked difference in accuracy between the clinical prognosis based on the patient's medical condition and the team forecast which also takes into account the evaluation of psychic and social elements; these elements must therefore be regarded as indispensable in estimating the patient's chances of recovery.

Specificity

It has been shown above that the *type* of distress suffered by the patient has no specific influence on his chances of recovery; it still remains to consider whether the *nature* of the distress is related to the chances of recovery. For this purpose the factors causing distress were classified as follows: quality of father and of mother as homemaker and educator; quality of family of origin; quality of patient's own family; dwelling situation; working situation; and miscellaneous difficulties. Each category may cover a score of different situations but for the sake of brevity no details are given here.

It was then observed whether patients in any one category had different results from the rest in the follow-up. Patients in one category of "distress" were compared with those in all other categories and also with patients who had the same complaint but only to the degree rated by the team as "stress". The results are shown in Table XIII. The first item of the Table gives in the first column the number of

Table XIII

FOLLOW-UP ASSESSMENT BY TYPES OF DISTRESS

Patients' Case-History	Follow-up Assessment	Patients suffering from one type of Distress (1)	Patients suffering from all other types of Distress (2)	Total (1) + (2)	Patients suffering from same type of stress as in Col. (1) (3)	Total (1) + (3)
Quality of Father	Satisfactory	62	163	225	140	202
	Unsatisfactory	177	357	534	74	251
	Total	239	520	759	214	453
Quality of Mother	Satisfactory	52	173	225	82	134
	Unsatisfactory	124	410	534	46	170
	Total	176	583	759	128	304
Quality of Family of Origin	Satisfactory	83	142	225	147	230
	Unsatisfactory	232	302	534	83	315
	Total	315	444	759	230	545
Health of Spouse	Satisfactory	41	109	150	72	113
	Unsatisfactory	132	244	376	45	177
	Total	173	353	526	117	290
Children	Satisfactory	18	161	179	24	42
	Unsatisfactory	52	391	443	20	72
	Total	70	552	622	44	114
Quality of Own Family	Satisfactory	65	121	186	49	114
	Unsatisfactory	178	275	453	30	208
	Total	243	396	639	79	322
Dwelling Situation	Satisfactory	38	180	218	68	106
	Unsatisfactory	76	421	497	20	96
	Total	114	601	715	88	202
Work Situation	Satisfactory	77	74	151	66	143
	Unsatisfactory	116	193	309	22	138
	Total	193	267	460	88	281
Miscellaneous Difficulties	Satisfactory	41	184	225	47	88
	Unsatisfactory	128	406	534	42	170
	Total	169	590	759	89	258
		All P-values $> 0{\cdot}001$			All P-values $< 0{\cdot}001$	

patients found to be satisfactory and unsatisfactory on follow-up who complained of the quality of their father and in whom this complaint was judged to be severe enough to be rated as distress. This number is set against that of the patients for whom any other type of distress was recorded (Col. 2). The third column shows the number of patients who had also complained about their father but in whom the team had not assessed this complaint as a distressing element.

The outcome of this comparison is remarkably uniform. When one type of distress is compared with all other types no relation is to be found with the follow-up result. But when one type of distress is compared with the same type of mere stress, a relationship exists without exception within the probability limit of 0·1 per cent. This confirms that the presence of distress has a decisive influence on the chance of recovery, but that the nature of the distress is immaterial.

Special attention was paid to the question whether there was any difference between the influence of recent occurrences of a serious nature and that of past occurrences, because 'a number of American workers (Engel, 1952; Litz, 1949; Bacon, Renneker, and Cutler, 1952; Miller, Lief, and Mittelman, 1953; Schmale, 1958) tend to show that recent losses are in some way connected with the onset of serious illness. If this were so it might be expected that persons admitted to hospital would show a higher frequency of loss of relatives than the general population, and that emergency admissions would show a higher proportion of losses and possibly other difficulties than non-urgent admissions. To eliminate the possible selective influence of emergency admissions the patients were noted who had suffered the loss of a near relative (parent, spouse, child) during the 12 months before admission. 82 of the total 1,630 patients were found to have suffered such a loss which is 5 per cent. The bereavement rate in Amsterdam was estimated at between 4 and 6 per cent. so that recent loss does not seem to be related to hospital admission.

Discussion

This sample of a hospital population brings to mind the warning of Hill (1950):

"It is not too much to say that there is hardly any disease in which a hospital population must not be regarded with suspicion if it is desired to argue from the sample to the universe of all patients".

There are many reasons for limiting these conclusions to the present sample, but it cannot be denied that something useful may be abstracted from this sample and placed within the frame of reference of more general medical problems. One case of cholera in a 100-bed hospital will not allow the conclusion that one per cent. of the general population is stricken by cholera or even that one per cent. of all hospital patients is suffering from this disease; but it may be concluded from this one case that the health of the population is seriously threatened. I venture to think that this investigation, independent of the limits of the sample, permits the posing of certain questions concerning the efficiency of the hospital as a link in the chain of aids to health.

It may seem superfluous to demonstrate that the patient who is burdened by cares or conflicts in his private life, will conquer his illness less easily than somebody who is not so burdened. The phenomenon may be self-evident but its consequences remain formidable.

Our investigation has shown that a favourable clinical prognosis was made in 1,128 of 1,630 cases. This means that medical science offered the possibility of recovery to over 69 per cent., but our follow-up showed that only 660 of the 1,128 favourable prognoses were realized. Even if the phenomenon of "distress" is regarded merely as a plodding and worrying attitude to life or as a psychological peculiarity of the patient, it is plain that such a mental attitude on the part of the patient reduces the efficiency of the hospital by almost half.

This may be self-evident, but it does not have to be accepted as unalterable. Even without following Balint (1957), and postulating that doctor and patient together build the illness, nobody will deny that doctor and patient together bring about recovery. Our investigation has shown that half of the hospital patients to whom the physician may be able to open the way to recovery, are unable to follow him. Perhaps it is true that these people do not recover because they plod along more heavily than others, because their burdens are larger, or their feet less nimble, but in such cases it must be one aspect of therapeutic action to make their going more easy, to lighten the burden, or to smooth their way. The need to give this help (after-care, social work, case-work, psychotherapy, etc.) must be determined during the stay in hospital, and should be part of the therapeutic programme even if the help to be given is outside the sphere of the hospital itself.

SUMMARY

In a sample of 1,630 patients from a general hospital in Amsterdam it was attempted to assess how far they suffered from social and/or psychic stresses to the extent of impeding their well-being. This assessment (the integrated evaluation) as well as the clinical prognosis of the case was compared with the actual condition of the patient some time after discharge from hospital.

A significant difference in the chance of recovery was found to exist between patients who had to cope with problems apart from their physical illness and those who did not.

The forecast of recovery based on the integrated assessment had a higher degree of accuracy than the forecast based on clinical data alone.

These results obtained irrespective of diagnosis and of the nature of the tensions from which the patient was suffering.

(1) By means of a team consisting of a general physician, a social worker, and a psychiatrist a routine method was developed of assessing the social and/or psychic tensions of patients admitted to a general hospital for a somatic illness.

(2) This team "integrated" assessment shows whether in addition to his somatic illness a patient is suffering from tensions (distress) which impede his well-being.

(3) A follow-up investigation showed a significant difference in frequency of recovery between distressed patients and patients without distress.

(4) Forecasts of the chance of recovery based on the team assessments were more frequently confirmed by follow-up than clinical forecasts based on the patient's physical illness.

(5) The social and psychic tensions amounting to "distress" were non-specific, and the distress was not related to any specific clinical diagnosis nor to specific traumatic occurrences in the patient's previous history or present situation.

It appears therefore that the team's integrated assessment of a patient's hope of recovery is more accurate than the clinical prognosis when both are measured against the follow-up result; this greater degree of accuracy may be due to the fact that the integrated assessment contains no specific elements and is more independent of diagnosis.

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APPENDIX

PROFORMA FOR PSYCHOSOCIAL CASE HISTORY

Date of Inquiry..... *Inquiry made by Dr*.....

No. of Case History..... *Dept*..... *Ward*.....

Name ..... *Unmarr./Marr./Div./Wid*.....

Address ..... *Religion* .....

Age..... *Date of Birth*..... *Date of Admission*.....

Diagnosis on Admission .....

(*contin.*)

(*contin.*)

PARENTAL FAMILY

Are your parents still alive?
How old is (was) your own father (when he died)?
What was the cause of his death?
How old were you when your father died (disappeared)?
What was your father's occupation?
How old is (was) your own mother (when she died)?
What was the cause of her death?
How old were you when your mother died (disappeared)?
Were you brought up by your parents?
Were your parents usually in good health?
Was it your parents' only marriage?
Are your parents divorced (separated)?
Did father/mother marry again?
How many years has your father/mother been alone?
How were you brought up then, where, and by whom?
How many children did your own parents have and what is your place among them?
How many children were you actually brought up with and what was your place among them?
About how old were your parents when you were born?
How old were you when you left home?
When did you come to this city?

EDUCATION

Have you attended normal elementary school (up to what grade)?
How often did you repeat a grade?
Did you have any further schooling or vocational training?
Did you have a practical vocational training?
Have you any certificates? If so, which?
Have you done your military service? If rejected, why?

VOCATION

What sort of work were you doing before admission? (If disabled, since when?)
Which other occupations have you had?
In which occupation did you stay the longest time and how long was that?
How many jobs have you had?
In which did you stay the longest time?
Have you (or your husband) often been without work (owing to illness or unemployment)?
What was the longest time?
What is/was the occupation of your husband/fiancé; if disabled, since when?
Does your wife work? Since when, and what are her working hours?
What do you do in your spare time; what are your hobbies?

MARRIAGE

How old were you when you married or became engaged for the first time?
How many years older/younger is your wife/fiancée (husband/fiancé) than you?
Is your husband/wife usually in good health?
Have you been married/engaged more than once, and if so how was the first marriage (engagement) terminated? (death, divorce?)
How long did the first (second) marriage last, and what were the intervals between them?
Was your husband/wife previously married?
When did your husband/wife die and of what?
Is the house large enough for your family? What space do you possess?

(*contin.*)

(contin.)

CHILDREN

How many children have you from this marriage?.....
Have you children from other marriages, and how many?.....
Has your husband/wife children from other marriages, and how many have been brought up by you?.....
Are any of your children sick, disabled or dead?.....
How old is your eldest and youngest child?.....
How many unmarried children live with you?.....
Have you any married children living with you?.....

ILLNESSES

How often have you been admitted to a hospital (for operation, observation)?.....
For which illnesses and when?.....
Have you ever been in a rest-home or sanatorium?.....
Have you (or your husband/wife, children) ever been in contact with a psychiatrist, a child-guidance clinic, the Department for Mental Hygiene, other social agencies?.....
How long have you had the complaints for which you have been admitted?.....
Have you had other complaints such as migraine, persistent headache, asthma, hay-fever, hives, pleuritis, tuberculous ailments, stomach complaints, gall bladder complaints, intestinal complaints (colitis), heart diseases, high blood pressure, diabetes, goitre, rheumatic complaints (treated with radiation in any form), accidents, and backaches?
.....
Do you consult your family doctor often?.....

SUBJECTIVE QUESTIONS

How was the harmony in the parental family (alcoholism, poverty, orderliness)?.....
Did you have a happy childhood or were there difficulties?.....
Are you satisfied with your schooling and vocational training?.....
Are you satisfied with your present job?.....
Do you mean to live in better circumstances than your parents did, or do you expect to live in the same or a less fortunate situation?.....
Do you have conflicts at work with superiors, colleagues, or subordinates?.....
How is the harmony in your own family, with your children (and sons- and daughters-in-law)?.....
How do you get on with your own family, your wife's/husband's family and your neighbours?.....
Have you debts or hire-purchase difficulties?.....
Are you able to pay for your diet?.....
What is your average weekly income and that of your wife and adult children?.....
What is your rent?.....

SUMMARY

By the General Physician:.....
By the Social Worker:.....
By the Psychiatrist:.....

CONCLUSION OF THE TEAM

No Stress ..... Stress ..... Distress .....
Som. ..... Psycho-Som. ..... Psycho-Som.-Soc. .....
Psych./Som. ..... Soc./Som./Psych. .....
No Joint Conclusion.....

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